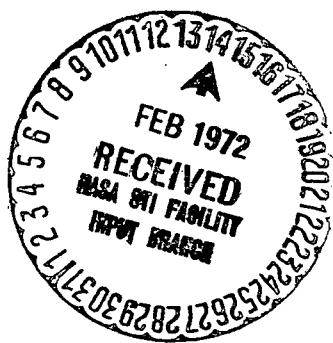




## -SPACE SHUTTLE-

# AERODYNAMIC CHARACTERISTICS OF THE NORTH AMERICAN ROCKWELL SPACE SHUTTLE DELTA-WING ORBITER (110C) ALONE AND WITH BELLY-MOUNTED EXTERNAL OXYGEN/HYDROGEN TANKS ( $M=0.6$ TO $5.0$ )

By  
E.C. Allen, NR



(NASA-CR-120014) AERODYNAMIC  
CHARACTERISTICS OF THE NORTH AMERICAN  
ROCKWELL SPACE SHUTTLE DELTA-WING ORBITER  
(110C) ALONE AND WITH E.C. Allen (Chrysler  
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Center

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SADSAC SPACE SHUTTLE  
AEROTHERMODYNAMIC  
DATA MANAGEMENT SYSTEM

CONTRACT NAS8-4016  
MARSHALL SPACE FLIGHT CENTER

SPACE DIVISION  CHRYSLER  
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January 1972

SADSAC/SPACE SHUTTLE

WIND TUNNEL TEST DATA REPORT

CONFIGURATION: NR-110C Orbiter Alone and with Belly Tanks

TEST PURPOSE: Static Stability and Control Investigation

TEST FACILITY: NASA/MSFC 14 x 14 Inch Trisonic Wind Tunnel

TESTING AGENCY: North American Rockwell Corporation

TEST NO. & DATE: MSFC TWT 509; Oct 18-21, 1971

FACILITY COORDINATOR: Jim Weaver, NASA, MSFC

PROJECT ENGINEER(S): E. C. Allen, NR.

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CONTRACT NAS 8-4016

AMENDMENT 153

DRL 184-58

This report has been prepared by Chrysler Corporation Space Division under a Data Management Contract to the NASA. Chrysler assumes no responsibility for the data presented herein other than its display characteristics.

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AERODYNAMIC CHARACTERISTICS OF THE NORTH AMERICAN ROCKWELL  
SPACE SHUTTLE DELTA WING ORBITER (110C) ALONE AND WITH  
BELLY MOUNTED EXTERNAL OXYGEN/HYDROGEN TANKS ( $M = 0.6$  TO  $5.0$ )

SUMMARY

Experimental aerodynamic investigations were conducted during October 1971 at the MSFC 14 x 14 Inch Trisonic Wind Tunnel on a .0044 scale model of the North American Rockwell Space Shuttle Orbiter, 110C. The test configurations included the orbiter alone and with external oxygen/hydrogen belly tanks. The six component aerodynamic force and moment data obtained cover a Mach number range from 0.6 to 4.96 at angles of attack from  $-10^\circ$  to  $60^\circ$  at  $0^\circ$  sideslip angle and  $-10^\circ$  to  $10^\circ$  at  $-6^\circ$  sideslip angle. Reynolds number per unit length varied somewhat with Mach number but was a nominal  $6.8 \times 10^6$  per foot.

## NOMENCLATURE

### (General)

<u>SYMBOL</u>	<u>SADSAC SYMBOL</u>	<u>DEFINITION</u>
$\alpha$	ALPHA	angle of attack, angle between the projection of the wind $X_w$ -axis on the body X, Z-plane and the body X-axis; degrees
$\beta$	BETA	sideslip angle, angle between the wind $X_w$ -axis and the projection of this axis on the body X-Z-plane; degrees
$\psi$	PSI	yaw angle, angle of rotation about the body Z-axis, positive when the positive X-axis is rotated toward the positive Y-axis; degrees
$\phi$	PHI	roll angle, angle of rotation about the body X-axis, positive when the positive Y-axis is rotated toward the positive Z-axis; degrees
$\rho$		air density; $\text{kg}/\text{m}^3$ , slugs/ $\text{ft}^3$
$a$		speed of sound; $\text{m/sec}$ , $\text{ft/sec}$
$v$		speed of vehicle relative to surrounding atmosphere; $\text{m/sec}$ , $\text{ft/sec}$
$q$	$Q(\text{PSI})$ $Q(\text{PSF})$	dynamic pressure; $1/2\rho V^2$ , psi, psf
$M$	MACH	Mach number; $V/a$
$RN/L$	RN/L	Reynolds number per unit length; million/ $\text{ft}$
$p$		static pressure; psi
$P$		total pressure; psi
$C_p$	CP	pressure coefficient; $(p-p_\infty)/q$

## NOMENCLATURE (Continued)

### Reference & C. G. Definitions

<u>SYMBOL</u>	<u>SADSAC SYMBOL</u>	<u>DEFINITION</u>
S		wing area; $\text{m}^2$ , $\text{ft}^2$
S	SREF	reference area; $\text{m}^2$ , $\text{ft}^2$
$\bar{c}$		wing mean aerodynamic chord or reference chord; m, ft, in (see $l_{\text{ref}}$ or LREF)
$l_{\text{ref}}$	LREF	reference length; m, ft, in.; (see $\bar{c}$ )
$b_{\text{ref}}$	BREF	wing span or reference span; m, ft, in
$A_b$		base area; $\text{m}^2$ , $\text{ft}^2$ , $\text{in}^2$
c. g.		center of gravity
MRP	MRP	abbreviation for moment reference point
XMRP		abbreviation for moment reference point on X-axis
YMRP		abbreviation for moment reference point on Y-axis
ZMRP		abbreviation for moment reference point on Z-axis

## NOMENCLATURE (Continued)

### Axis System General

<u>SYMBOL</u>	<u>DEFINITION</u>
F	force; F, lbs
M	moment; M, in-lb

<u>Subscript</u>	<u>Definition</u>
N	normal force
A	axial force
L	lift force
D	drag force
Y	force or moment about the Y axis
Z	moment about the Z axis
X	moment about the X axis
s	stability axis system
w	wind axis system
ref	reference conditions
$\infty$	free stream conditions
t	total conditions
b	base

**NOMENCLATURE (Continued)**  
**Body & Stability Axis System**

<u>SYMBOL</u>	<u>SADSAC SYMBOL</u>	<u>DEFINITION</u>
<b><u>Body Axis System</u></b>		
$C_N$	CN	normal force coefficient; $F_N/qS$
$C_A$	CA	axial force coefficient; $F_A/qS$
$C_{A_b}$	CAB	base axial force coefficient; $[-1] \left[ (p_b - p_\infty)/q \right] (A_b/S)$
$C_{A_f}$	CAF	forebody axial force coefficient; $C_A - C_{A_b}$
$C_n$	CYN	yawing moment coefficient; $M_Z/qS b_{ref}$
$C_\ell$	CBL	rolling moment coefficient; $M_X/qS b_{ref}$
<b><u>Common to Both Axis Systems</u></b>		
$C_m$	CLM	pitching moment coefficient; $M_Y/qS l_{ref}$
$C_y$	CY	side force coefficient; $F_Y/qS$
<b><u>Stability Axis System</u></b>		
$C_L$	CL	lift force coefficient; $F_L/qS$
$C_D$	CD	drag force coefficient; $F_D/qS$
$C_{D_b}$	CDB	base drag coefficient
$C_{D_f}$	CDF	forebody drag coefficient; $C_D - C_{D_b}$
$C_n$	CLN	yawing moment coefficient; $M_{Z,s}/qS b_{ref}$
$C_\ell$	CSL	rolling moment coefficient; $M_{X,s}/qS b_{ref}$
L/D	L/D	lift-to-drag ratio; $C_L/C_D$
L/D <sub>f</sub>	L/DF	lift to forebody drag ratio; $C_L/C_{D_f}$

## NOMENCLATURE (Continued)

### Surface Definitions

<u>SYMBOL</u>	<u>SADSAC SYMBOL</u>	<u>DEFINITION</u>
$i_t$	HORIZT	horizontal tail incidence; positive when trailing edge down; degrees
$\delta$		symmetrical surface deflection angle; degrees; positive deflections are:
	AILRDN	aileron - total aileron deflection; (left aileron - right aileron)/2
	CANARD	canard - trailing edge down
	ELEVON	elevon - trailing edge down
	ELEVTR	elevator - trailing edge down
	FLAP	flap - trailing edge down
	RUDDER	rudder - trailing edge to the left
	SPOILR	spoiler - trailing edge down
	TAB	tab - trailing edge down with respect to control surface
$\delta$		antisymmetrical surface deflection angle, degrees; positive trailing edge down: left aileron - trailing edge down right aileron - trailing edge down left elevon - trailing edge down right elevon - trailing edge down left spoiler - trailing edge down right spoiler - trailing edge down

<u>SURFACE SUBSCRIPTS</u>	<u>DEFINITION</u>
a	aileron
b	base
c	canard
e	elevator or elevon
f	flap
r	rudder or ruddervator
s	spoiler
t	tail

## CONFIGURATIONS INVESTIGATED

0.0044 scale model components of the NR110C delta wing orbiter tested included:

- B<sub>12</sub> - basic orbiter fuselage
- B<sub>13</sub> - same fuselage as B<sub>12</sub> except nose is drooped
- B<sub>14</sub> - same fuselage as B<sub>12</sub> except nose is uniform and has no canopy
- K<sub>3</sub> - bubble shaped pilots enclosure (canopy) used with B<sub>14</sub>
- W<sub>26</sub> - delta wing with 5° twist and rounded wing tips
- E<sub>16</sub> - elevons used with wing W<sub>26</sub>
- V<sub>36</sub> - centerline mounted vertical tail
- T<sub>2</sub> - oxygen/hydrogen tanks

The Data Set Collations, Table I, show the various combinations of the above components tested. Pertinent dimensional information for the components is given in Table III, Model Component Descriptions Sheets, while the figures show the overall configuration lines.

## TEST FACILITY DESCRIPTION

The Marshall Space Flight Center 14" x 14" Trisonic Wind Tunnel is an intermittent blowdown tunnel which operates by high pressure air flowing from storage to either vacuum or atmospheric conditions. A Mach number range from .2 to 5.85 is covered by utilizing two interchangeable test sections. The transonic section permits testing at Mach 0.20 through 2.50, and the supersonic section permits testing at Mach 2.74 through 5.85. Mach numbers between .2 and .9 are obtained by using a controllable diffuser. The range from .95 to 1.3 is achieved through the use of plenum suction and perforated walls. Mach numbers of 1.44, 1.93 and 2.50 are produced by interchangeable sets of fixed contour nozzle blocks. Above Mach 2.50 a set of fixed contour nozzle blocks are tilted and translated automatically to produce any desired Mach number in .25 increments.

Air is supplied to a 6000 cubic foot storage tank at approximately -40°F dew point and 500 psi. The compressor is a three-stage reciprocating unit driven by a 1500 hp motor.

The tunnel flow is established and controlled with a servo actuated gate valve. The controlled air flows through the valve diffuser into the stilling chamber and heat exchanger where the air temperature can be controlled from ambient to approximately 180°F. The air then passes through the test section which contains the nozzle blocks and test region.

Downstream of the test section is a hydraulically controlled pitch sector that provides a total angle of attack range of 20° ( $\pm 10^\circ$ ). Sting offsets are available for obtaining various maximum angles of attack up to 25°.

## REDUCTION OF DATA

The aerodynamic loads on the model were recorded by a six component internal strain gage balance. The balance measured loads were corrected for tare loads and reduced to coefficient form using the following reference dimensions:

$$S_{REF} = \text{wing planform area} = 9.442 \text{ sq. inches}$$

$$l_{REF} = \bar{c} = \text{wing mean aerodynamic chord} = 2.693 \text{ inches}$$

$$b_{REF} = \text{wing span} = 4.678 \text{ inches}$$

Aerodynamic moments are referenced to a c.g. location at fuselage station 3.608 on waterline -0.096, see Figure D.

Static pressure was measured at two locations on the orbiter base and at one point in the sting cavity regions. These pressures were utilized to correct the balance measured axial force to a condition corresponding to free-stream pressure acting on the base and cavity area. The equations utilized for this correction were:

$$C_{AF} = C_A - (C_{AB} - C_{AC})$$

where

$$C_{AB} = - \left[ \frac{(0.5)(P_{B1} + P_{B2}) - P_{\infty}}{q_{\infty}} \right] (A_B/S_{REF})$$

and

$$C_{AC} = - \left[ (P_C - P_{\infty})/q_{\infty} \right] (A_C/S_{REF})$$

The areas affected were:

$$A_B = \text{orbiter base area} = 0.497 \text{ sq. inches}$$

$$A_C = \text{balance cavity area} = 0.503 \text{ sq. inches}$$

The center of pressure locations on the plots are shown as a percent of fuselage reference length and where computed by the equation.

$$XCP/L = XCG/L - (CLM/CN) (\bar{C}/L)$$

where

XCP/L = center of pressure location as % body length

XCG/L = reference center of gravity location as % body length

CLM = aerodynamic pitching moment coefficient

CN = aerodynamic normal force coefficient

$\bar{C}$  = mean aerodynamic chord

L = reference body length = 5.9048 inches

#### TABULATED DATA LISTING

A tabulated data listing, consisting of all aero data sets, both original and those created in arriving at the plotted material to be presented subsequently, is available as an addendum to this report. The tabular listing is made up in two sections:

- (a) a brief summary list of all data sets containing the identifier, the descriptor, and the resident dependent variables.
- (b) a full list of all data sets containing all resident or selected aerodynamic coefficients of the data sets as well as the above mentioned information.

The listing is currently sent on limited distribution to the following organizations:

NASA AMES	Mr. V. Stevens
NASA MSFC	Mr. J. Weaver
NR	Mr. C. Leef

If copies of this listing are desired, please contact the above or the cognizant SADSAC personnel who, for this data, is:

Department 2780  
Chrysler Corporation Space Division  
New Orleans, La. 70129  
(504) 255-2304

**TABLE I. TEST TWT-509 DATA SET COLLATION SHEET**  
**Force - 110C OBSTACLE ALONE AND OBSTACLE + BELLY TANK,**  
**0.0044-SCALE**

□ PRETEST       POSTTEST

DATA SET IDENTIFIER	CONFIGURATION	SCHED.	CONTROL DEFLECTIONS α    β	NO. of RUNS	NACH NUMBERS							
					0.6	0.9	1.2	1.9	2.9	4.9		
R5101A	B12W26E16J36	A	0	6	02%	01%	01%	02%	00%	00%		
		B		6	015/6	014/6	017/6	038/6	004/6	012/6		
		C	↑	2								
		A	6	6	051/6	042/6	063/6	056/6	049/6	050/6		
		B		6	032/6	021/6	039/6	041/6	006/6	005/6		
		C	↑	2	6	027/6	028/6	029/6	042/6	057/6	054/6	
		A		6	021/6	022/6	023/6	024/6	011/6	012/6		
		B		6	024/6	025/6	024/6	039/6	010/6	009/6		
		C	↑	2								
		A	6	6	020/6	059/6	058/6	057/6	052/6	051/6		
		B		6	044/6	045/6	064/6	055/6	053/6	054/6		
		C	↑	6	033/6	024/6	035/6	034/6	002/6	001/6		
		A		6								
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		C	↑	6								

**TABLE II**  
**TEST CONDITIONS**  
**TEST TWT-509**

**BALANCE UTILIZED:** Task 0.7-inch MK 1-A Six Component

**CAPACITY:**

#### ACCURACY:

## **COEFFICIENT TOLERANCE:**

NF	<u>400 lbs</u>
SF	<u>100 lbs</u>
AF	<u>15 lbs</u>
PM	
YM	
RM	<u>70 in lbs</u>

A set of five horizontal black lines, evenly spaced, used as a visual element.

0.3%  
0.3%  
0.3%  
  
0.3%

**COMMENTS:**

No satisfactory method is known for determining the absolute accuracy of the final data coefficients.

TABLE III. MODEL COMPONENT DESCRIPTIONS

MODEL COMPONENT: BODY .. B12

GENERAL DESCRIPTION: Basic fuselage of delta wing orbiter per NR lines dwg.9992-110C hybrid configuration. Symmetrical nose pilots enclosure is included.

Model Scale = 0.0044

DRAWING NUMBER: S-980-10,-11,-14, (-26 or -27), (-28 or -29)

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length, in.	<u>1355.00</u>	<u>5.955</u>
Max. Width, in.	<u>277.27</u>	<u>1.220</u>
Max. Depth,	<u>231.82</u>	<u>1.020</u>
Fineness Ratio	<u>4.898</u>	<u>4.898</u>
Area, ft <sup>2</sup>		
Max. Cross-Sectional	<u>416.41</u>	<u>0.00806</u>
Planform	<u>DNA</u>	<u>DNA</u>
Wetted	<u>DNA</u>	<u>DNA</u>
Base	<u>DNA</u>	<u>DNA</u>

TABLE III. (con't)

MODEL COMPONENT: BODY - B13GENERAL DESCRIPTION: Basic fuselage of delta wing orbiter per NR lines Dwg.9992-11OC with 11OC2 nose. Same as B12 except nose is drooped. Pilots  
enclosure is included.Model Scale = 0.0044DRAWING NUMBER: S-980-11,-15,-17,(-26 or -27), (-28 or -29), -38

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length, in.	<u>1355.0</u>	<u>5.955</u>
Max. Width, in.	<u>277.27</u>	<u>1.220</u>
Max. Depth, in.	<u>231.82</u>	<u>1.020</u>
Fineness Ratio	<u>4.898</u>	<u>4.898</u>
Area, ft <sup>2</sup>		
Max. Cross-Sectional	<u>416.41</u>	<u>0.00806</u>
Planform	<u>DNA</u>	<u>DNA</u>
Wetted	<u>DNA</u>	<u>DNA</u>
Base	<u>DNA</u>	<u>DNA</u>

TABLE III. (con't)

MODEL COMPONENT: BODY - Bl<sup>4</sup>GENERAL DESCRIPTION: Basic fuselage of delta wing orbiter per NR linesDwg. 9992-11OC; approximating NASA 040A configuration. Same as Bl2 except  
nose is uniform with no canopy.Model Scale = 0.0044DRAWING NUMBER: S-980-10,-11,-14, (-26 or -27), (-28 or -29), -36

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length, in.	<u>1355.0</u>	<u>5.955</u>
Max. Width, in.	<u>277.27</u>	<u>1.220</u>
Max. Depth, in.	<u>231.82</u>	<u>1.020</u>
Fineness Ratio,	<u>4.898</u>	<u>4.898</u>
Area, ft <sup>2</sup>		
Max. Cross-Sectional	<u>416.41</u>	<u>0.00806</u>
Planform	<u>DNA</u>	<u>DNA</u>
Wetted	<u>DNA</u>	<u>DNA</u>
Base	<u>DNA</u>	<u>DNA</u>

TABLE III. (con't)

MODEL COMPONENT: BODY - CANOPY - K3

GENERAL DESCRIPTION: Bubble shaped pilots enclosure used with delta wing  
orbiter Body Bl4. Canopy extends above fuselage upper mold line and is  
located between Fus. Sta. 238.64 and 368.18. Follows NASA 040A Dwg.

Model Scale = 0.0044DRAWING NUMBER: S-980-37

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length	_____	_____
Max. Width	_____	_____
Max. Depth	_____	_____
Fineness Ratio	_____	_____
Area	_____	_____
Max. Cross-Sectional	_____	_____
Planform	_____	_____
Wetted	_____	_____
Base	_____	_____

TABLE III. (con't)

MODEL COMPONENT: WING - W26

GENERAL DESCRIPTION: Delta wing with  $-5^\circ$  twist and rounded wing tips. Follows NR lines Dwg. 9992-110B.

Model Scale = 0.0044

DRAWING NUMBER: S-980-2, -3, -4, -7, -13

DIMENSIONS:FULL-SCALEMODEL SCALETOTAL DATA

Area, ft <sup>2</sup>		
Planform	3753.00	0.07266
Wetted	-	-
Span (equivalent), in.	972.44	4.279
Aspect Ratio	1.737	1.737
Rate of Taper	1.719	1.719
Taper Ratio	0.138	0.138
Diehedral Angle, degrees	7.000	7.000
Incidence Angle, degrees	0.000	0.000
Aerodynamic Twist, degrees (about T.E.)	-5.000	-5.000
Incidence, Root(E.P. 120.00)	0.000	0.000
Incidence, Tip (B.P. 493.50)	-5.000	-5.000
Sweep Back Angles, degrees		
Leading Edge	60.000	60.000
Trailing Edge	0.000	0.000
0.25 Element Line	52.410	52.410
Chords: in.		
Root (Wing Sta. 0.0)	976.84	4.298
Tip, (equivalent)(W.S. 489.87)	134.72	0.593
MAC (W.S. 183.08)	662.11	2.913
Fus. Sta. of .25 MAC	862.01	3.793
W.P. of .25 MAC	-86.42	-0.380
B.L. of .25 MAC	181.72	0.800
Airfoil Section		
Root (W.S. 120.90)	NACA 0006-64	
Tip (W.S. 497.20)	NACA 0009-64	

EXPOSED DATA

Area, ft <sup>2</sup>	2378.	0.04604
Span, (equivalent), in.	747.24	3.288
Aspect Ratio	1.618	1.618
Taper Ratio	0.172	0.172
Chords : in.		
Root (Equiv.)(W.S. 113.44)	781.82	3.440
Tip (Equiv.)(W.S. 489.87)	134.72	0.593
MAC (W.S. 257.36)	534.41	2.351
Fus. Sta. of .25 MAC	957.78	4.214
W.P. of .25 MAC	-77.37	-0.340
B.L. of .25 MAC	255.44	1.124
Leading Edge Cuff		
Planform Area, ft <sup>2</sup>	43.65	0.00085
L.E. Intersects Fus. M at Sta. in.	420.45	1.850
L.E. Intersects Wing L.E. at Sta.,in.	715.91	3.150

TABLE III. (con't)

MODEL COMPONENT: ELEVON - E16 (Data for one of two sides)

GENERAL DESCRIPTION: Full-span, constant chord elevon located on  
Delta Wing W26.

Model Scale = 0.0044

DRAWING NUMBER: S-980-30, -31 or -32, -33

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Area (True), ft <sup>2</sup>	<u>330.87</u>	<u>0.00641</u>
Span (equivalent), in.	<u>377.73</u>	<u>1.662</u>
Inb'd equivalent chord (W.S. 114.85)	<u>126.14</u>	<u>0.555</u>
Outb'd equivalent chord (W.S. 492.59)	<u>126.14</u>	<u>0.555</u>
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	<u>0.162</u>	<u>0.162</u>
At Outb'd equiv. chord	<u>0.970</u>	<u>0.970</u>
Sweep Back Angles, degrees		
Leading Edge	<u>0.000</u>	<u>0.000</u>
Tailing Edge	<u>0.000</u>	<u>0.000</u>
Hingeline	<u>0.000</u>	<u>0.000</u>
Area Moment (Normal to hinge line) (Product of area and mean chord)	<u>3480.26</u>	<u>0.00030</u>

TABLE III. (con't)

MODEL COMPONENT: VERTICAL TAIL - V36

GENERAL DESCRIPTION: Centerline vertical on delta wing configuration with 10° wedge airfoil, leading edge radius and blunt trailing edge. Follows NR lines  
 Dwg. 9992-110C.

Model Scale = 0.0044

DRAWING NUMBER: S-980-12

DIMENSIONS:

	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
<u>TOTAL DATA</u>		
Area	323.95	0.00627
*Void (INCLUDED ABOVE)	0.46	0.00001
Blanketed	0.00	0.00000
Span (equivalent), in.	251.51	1.107
Aspect Ratio	1.356	1.356
Rate of Taper	0.718	0.718
Taper Ratio	0.345	0.345
Diehedral Angle, degrees	-	-
Incidence Angle, degrees	-	-
Aerodynamic Twist, degrees	-	-
Toe-In Angle	0.000	0.000
Cant Angle	0.000	0.000
Sweep Back Angles, degrees		
Leading Edge	50.000	50.000
Trailing Edge	25.350	25.350
0.25 Element Line	45.349	45.349
Chords: in.		
Root (W.P. 113.61)	275.77	1.213
Tip, (equivalent)(W.P. 365.12)	95.19	0.419
MAC (W.P. 218.96)	200.13	0.881
Fus. Sta. of .25 MAC	1232.28	5.422
W.P. of .25 MAC	218.96	0.963
B.L. of .25 MAC	0.00	0.000
Airfoil Section 5° half angle wedge with blunt T.E.		
L.E.R.(W.P. 115.00), % chord	1.572	1.572
L.E.R.(W.P. 282.89), % chord	1.654	1.654

EXPOSED DATA

Area	_____	_____
Span, (equivalent)	_____	_____
Aspect Ratio	_____	_____
Taper Ratio	_____	_____
Chords		
Root	_____	_____
Tip	_____	_____
MAC	_____	_____
Fus. Sta. of .25 MAC	_____	_____
W.P. of .25 MAC	_____	_____
B.L. of .25 MAC	_____	_____

\*This area is the void area located at  
 the lower aft portion of the surface.

TABLE III. (concl'd)

MODEL COMPONENT: BODY - TANK - T2

GENERAL DESCRIPTION: Body of revolution with 20° half angle nose cone attached to lower surface of Body Bl2 by means of a hex shaped pylon. Pylon is included.

Model Scale = 0.0044

DRAWING NUMBER: S-980-34, -39

<u>DIMENSIONS: (Tank)</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length, in.	<u>1742.58</u>	<u>7.667</u>
Max. Width, in.	<u>275.45</u>	<u>1.212</u>
Max. Depth, in.	<u>275.45</u>	<u>1.212</u>
Fineness Ratio	<u>6.326</u>	<u>6.326</u>
Area, ft <sup>2</sup>		
Max. Cross-Sectional	<u>413.84</u>	<u>0.00801</u>
Nose Cone L.E.R., in.	<u>15.91</u>	<u>0.070</u>
Wetted	<u>DNA</u>	<u>DNA</u>
Base	<u>DNA</u>	<u>DNA</u>
<u>PYLON</u>		
Length, in	<u>740.91</u>	<u>3.260</u>
Width, in	<u>90.91</u>	<u>0.400</u>
Section, % Hex	<u>13.497 - 86.503</u>	

TABLE IV. INDEX OF MODEL FIGURES

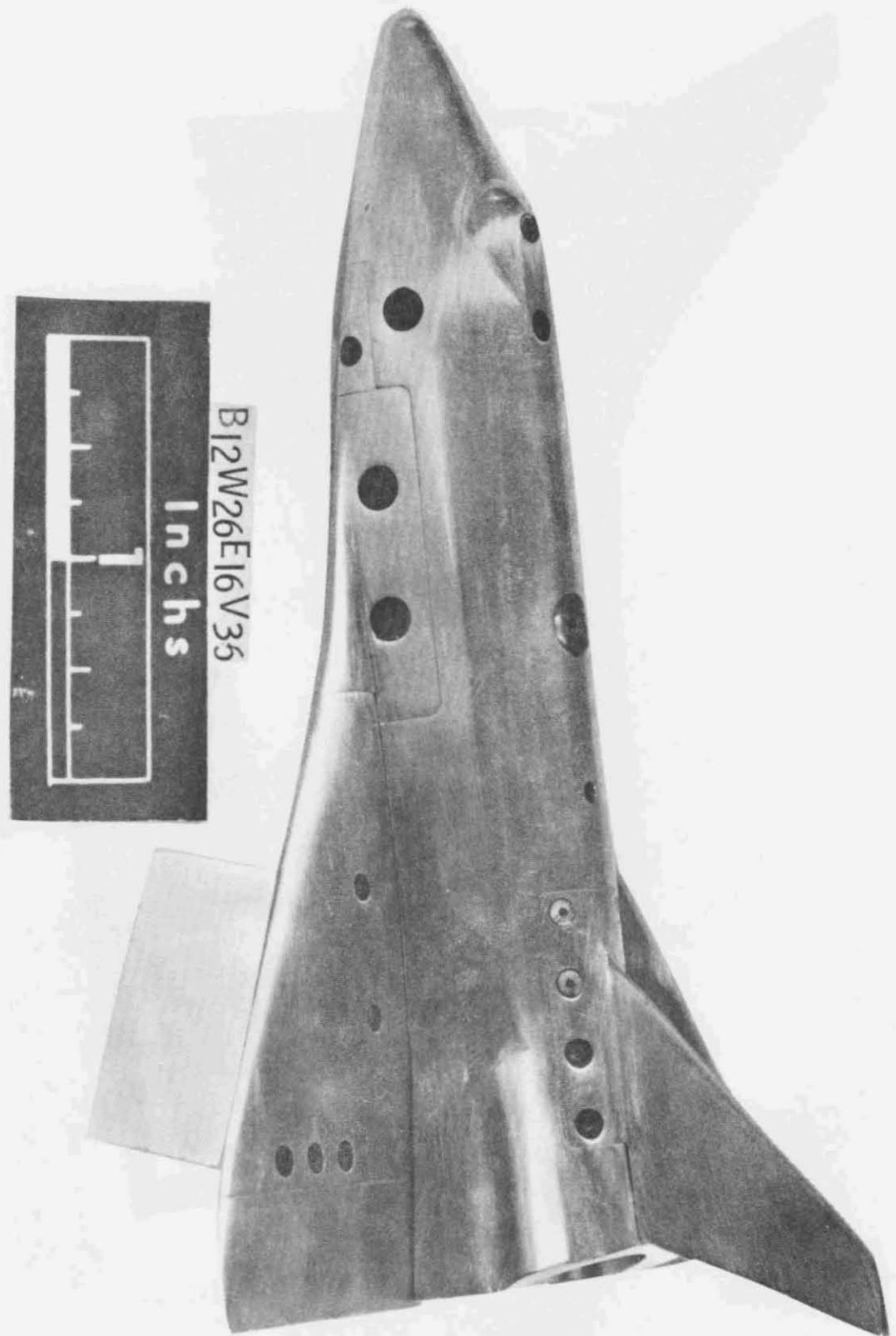
Figure A. Photograph of Configuration $B_{12}W_{26}E_{16}V_{36}$	23
Figure B. Photograph of Configuration $B_{14}K_3W_{26}E_{16}V_{36}$	24
Figure C. Photograph of Configuration $B_{12}W_{26}E_{16}V_{36}+T_2$	25
Figure D. Location of Moment Reference Point	26
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2) Configuration $B_{13}W_{26}E_{16}V_{36}$	27
3) Configuration $B_{14}K_3W_{26}E_{16}V_{36}$	28
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Figure F. Body $B_{13}$	31
Figure G. Body $B_{14}$	32
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Effect of Body Nose Shape on Basic Longitudinal Characteristics	A	Configuration and Mach	1-48
Effect of Body Nose Shape on Design Functions at Maximum L/D	B	Configuration	49-51
Effect of Belly Tanks on Basic Longitudinal Characteristics	A	Configuration and Mach	52-59
Effect of Belly Tanks on Design Functions at Maximum L/D	B	Configuration	100-102
Effect of Sideslip on Basic Lateral-Directional Characteristics	C	Mach, Beta	103-120
Effect of Sideslip on Basic Lateral-Directional Characteristics	D	Mach, Beta	121-132
Effect of Sideslip on Basic Lateral-Directional Characteristics	C	Mach, Beta	133-150
Effect of Sideslip on Basic Lateral-Directional Characteristics	D	Mach, Beta	151-162
Effect of Sideslip on Basic Lateral-Directional Characteristics	C	Mach, Beta	163-180
Effect of Sideslip on Basic Lateral-Directional Characteristics	D	Mach, Beta	181-192

## PLOTTED COEFFICIENTS SCHEDULE:

- (A) CN, CAF, CAB, CLM, CL, CDF, L/DF, XCP/L vs. ALPHA  
 (B) L/DFMX, ALLDFX, CLLDFX vs. MACH
- (C) CY, CYN, CBL vs. ALPHA  
 (D) CLN, CSL vs. ALPHA



B12W26E16V36

inches

FIGURE A. PHOTOGRAPH OF CONFIGURATION B12W26E16V36

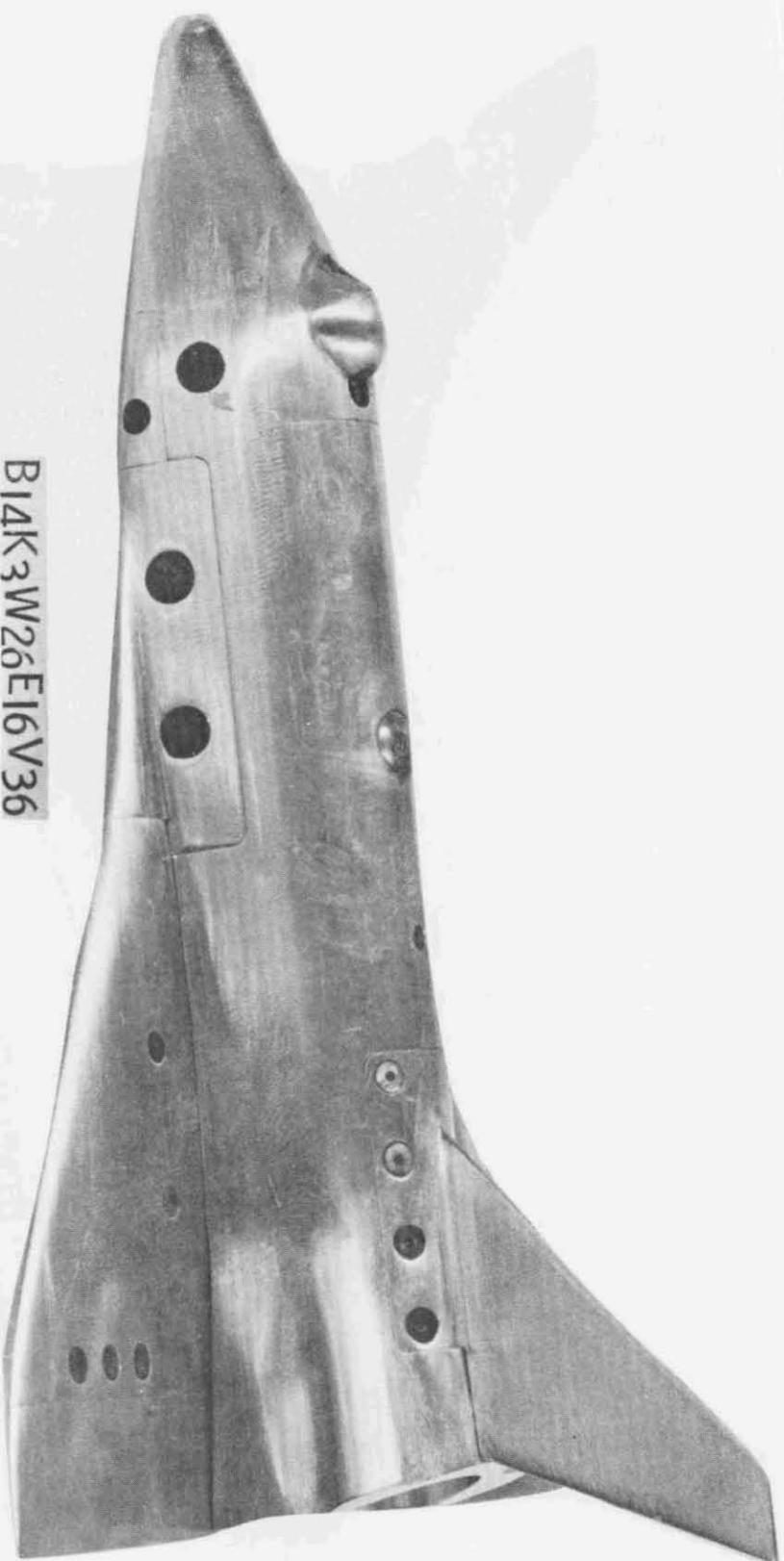
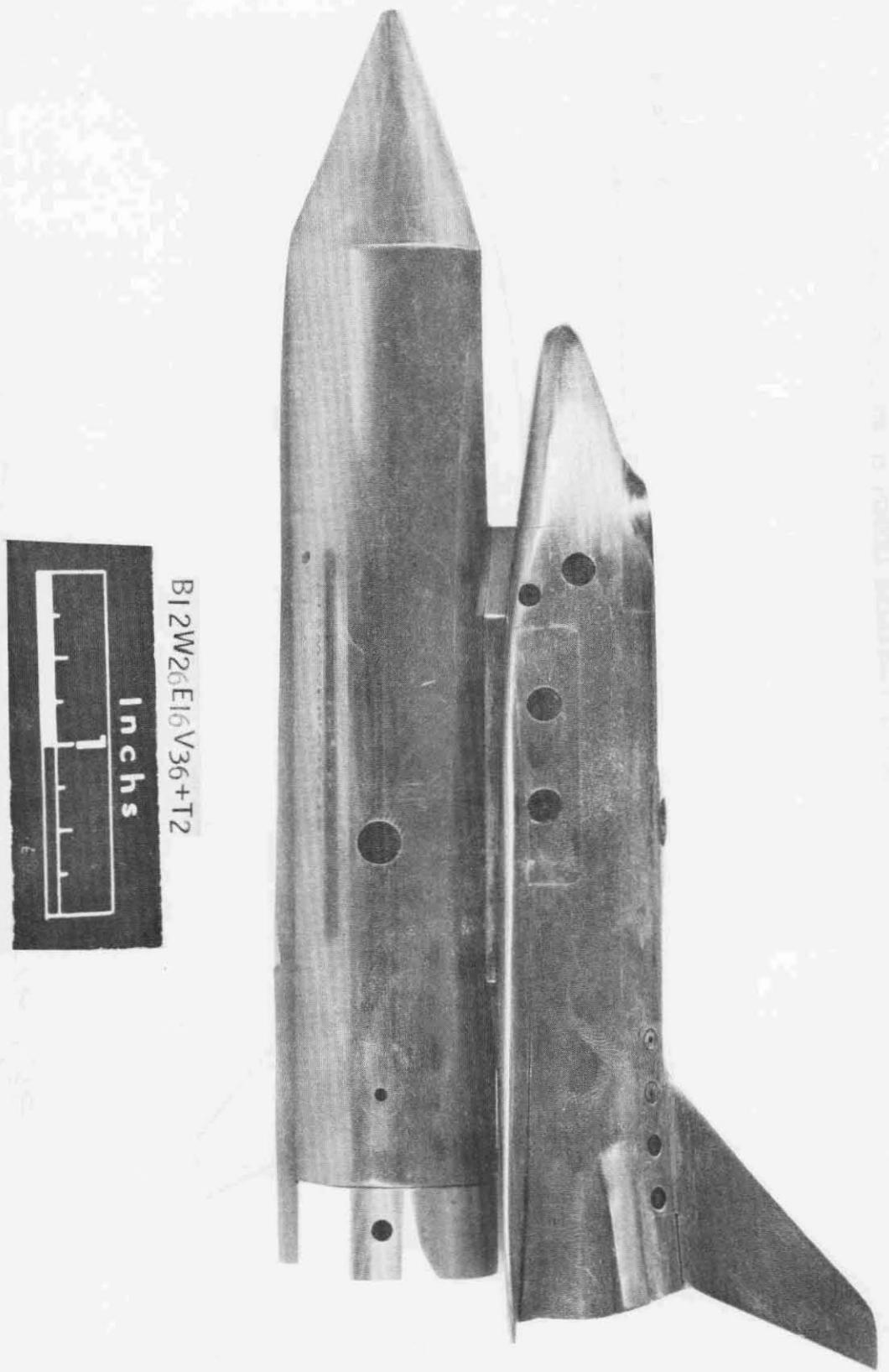


FIGURE B. PHOTOGRAPH OF CONFIGURATION B14K<sub>3</sub>W26E16V36

FIGURE C. PHOTOGRAPH OF CONFIGURATION B<sub>12</sub>W<sub>26</sub>E<sub>16</sub>V<sub>36</sub>+T<sub>2</sub>



SSV Config. B<sub>12</sub> M<sub>26</sub> E<sub>16</sub> V<sub>36</sub>

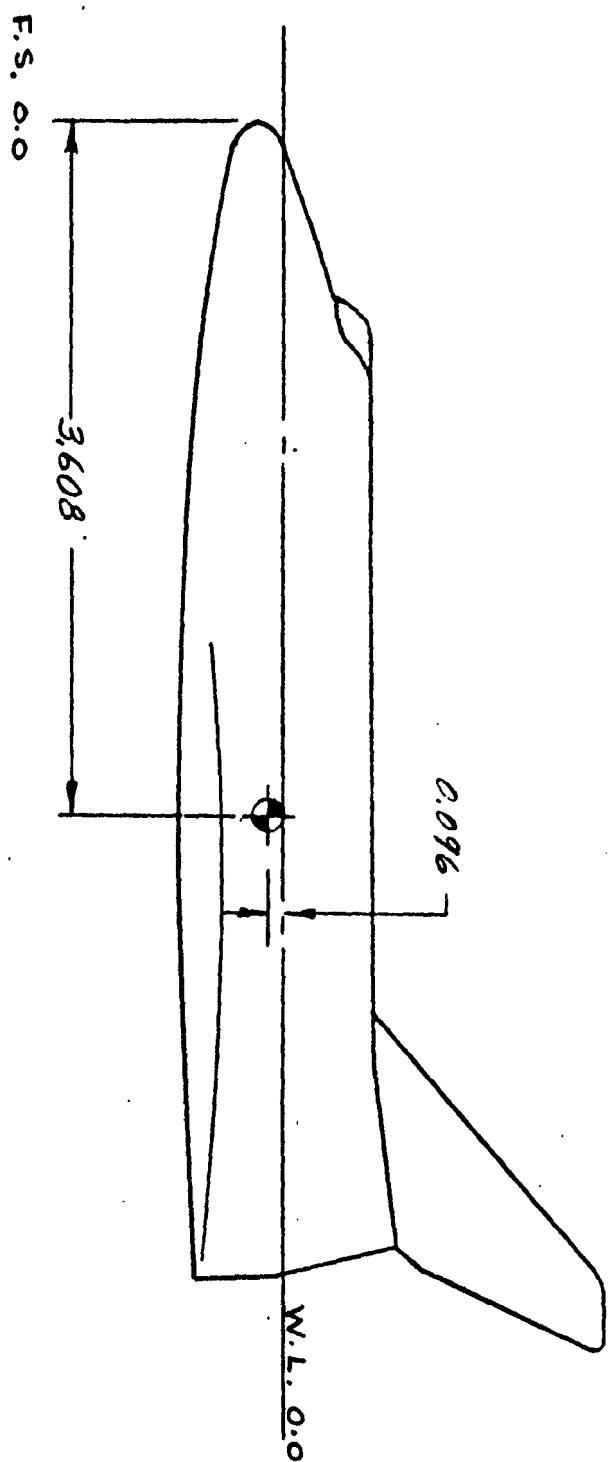


Figure D. LOCATION OF MOMENT REFERENCE POINT  
1) Configuration B<sub>12</sub> M<sub>26</sub> E<sub>16</sub> V<sub>36</sub>

SSV Conv. B<sub>13</sub> W<sub>26</sub> E<sub>16</sub> V<sub>36</sub>

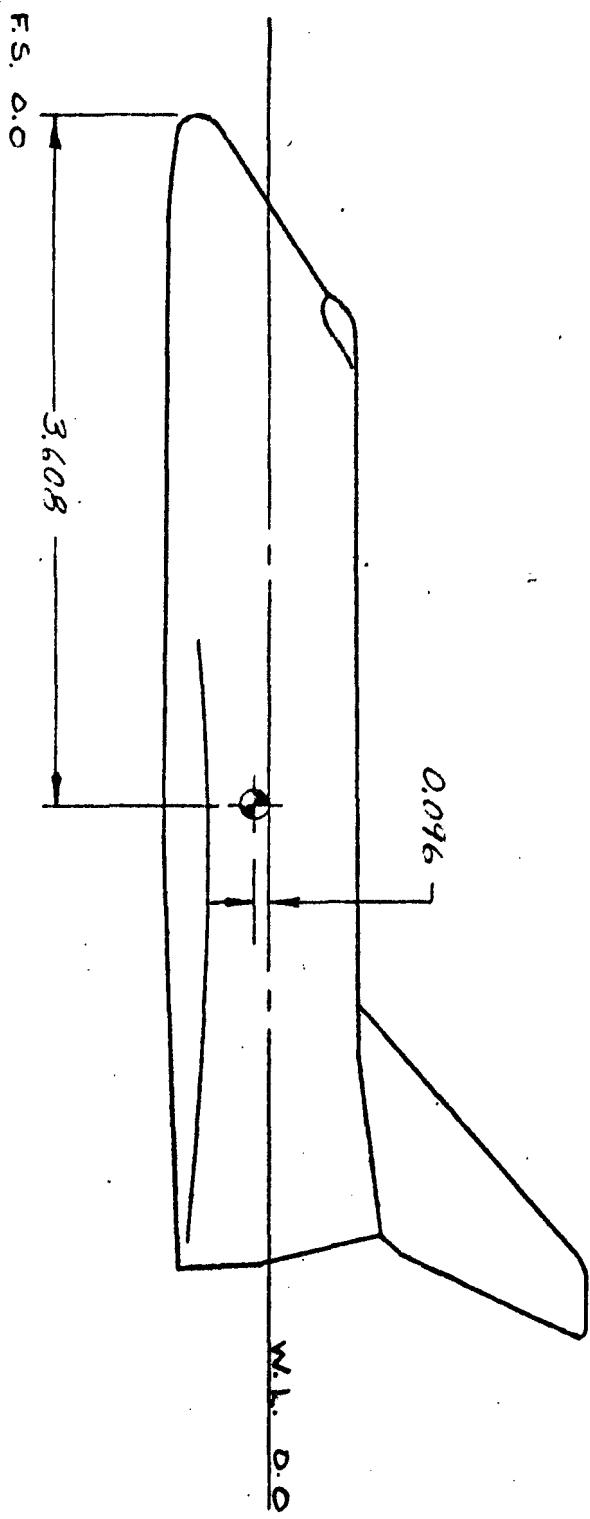


FIGURE D. LOCATION OF MOMENT REFERENCE POINT (Continued)  
2) Configuration B<sub>13</sub>W<sub>26</sub>E<sub>16</sub>V<sub>36</sub>

SSV Config. B<sub>14</sub>K<sub>3</sub>W<sub>26</sub>E<sub>16</sub>V<sub>36</sub>

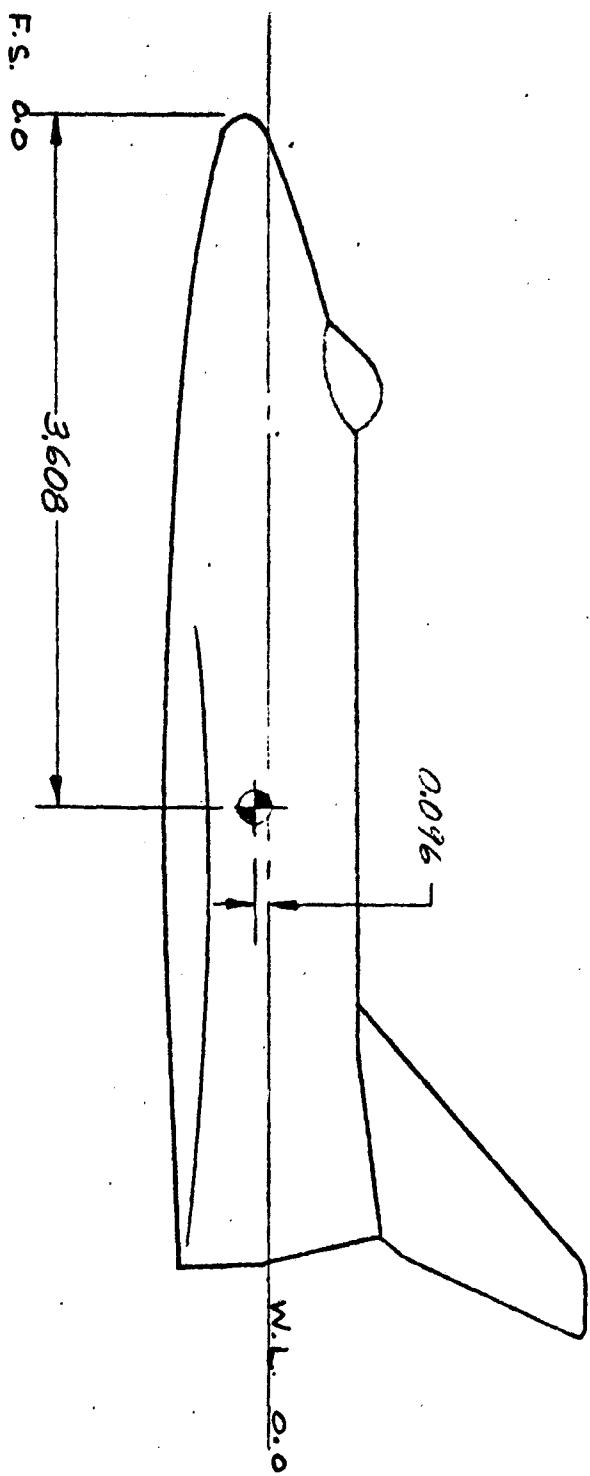


FIGURE D. LOCATION OF MOMENT REFERENCE POINT (Continued)  
3) Configuration B<sub>14</sub>K<sub>3</sub>W<sub>26</sub>E<sub>16</sub>V<sub>36</sub>

SSV Config. B<sub>12</sub> W<sub>26</sub> E<sub>16</sub> V<sub>36</sub> + T<sub>2</sub>

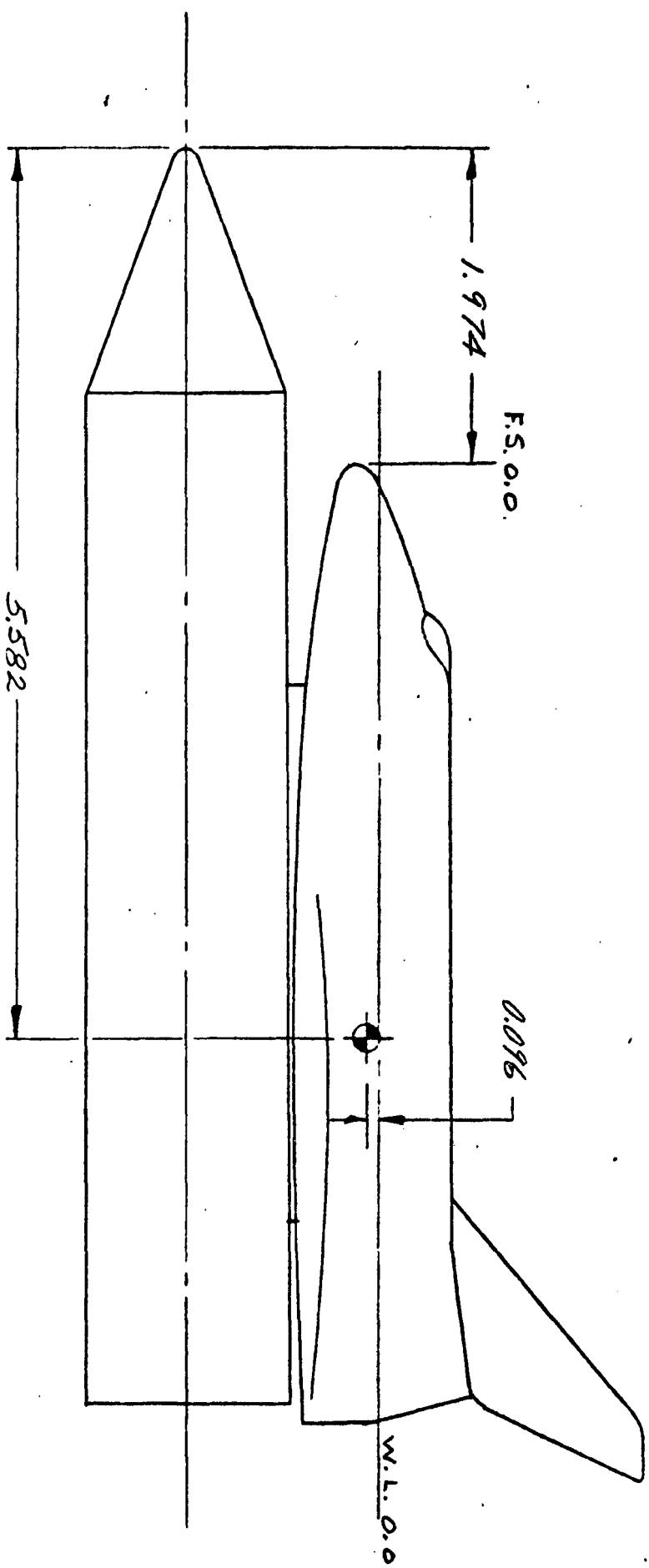


FIGURE D. LOCATION OF MOMENT REFERENCE POINT (Continued)  
4) Configuration B<sub>12</sub> W<sub>26</sub> E<sub>16</sub> V<sub>36</sub> + T<sub>2</sub>

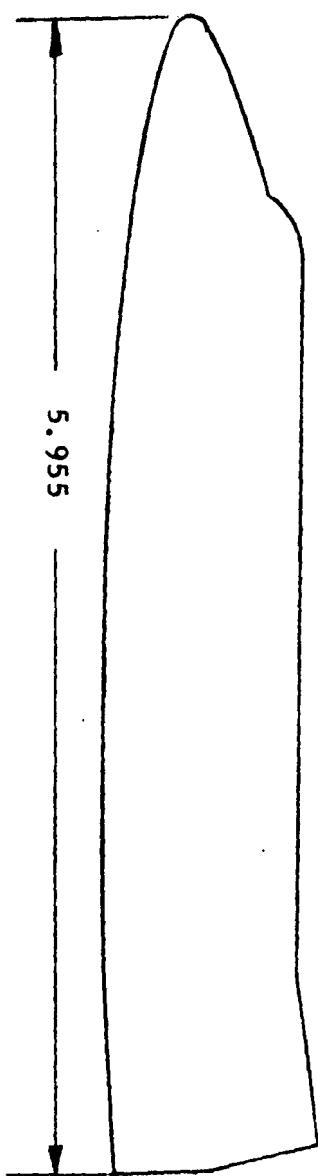


FIGURE E. BODY - B12

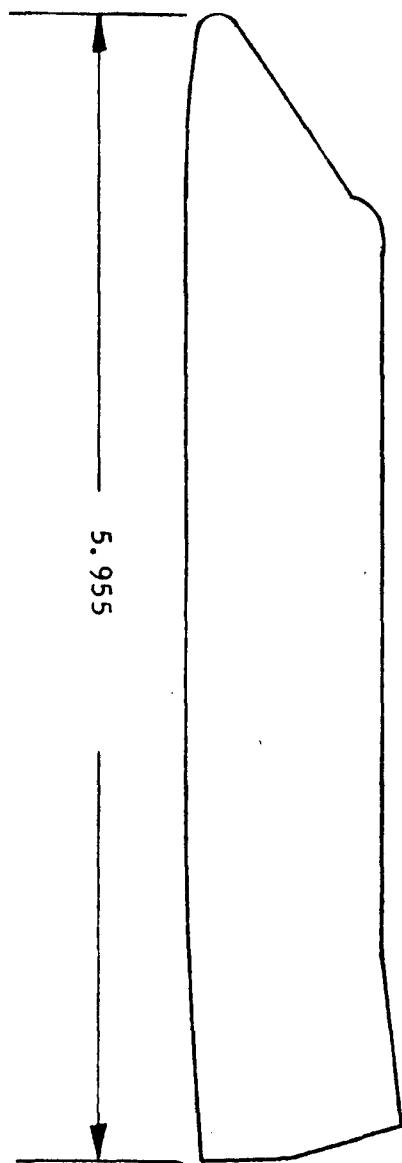
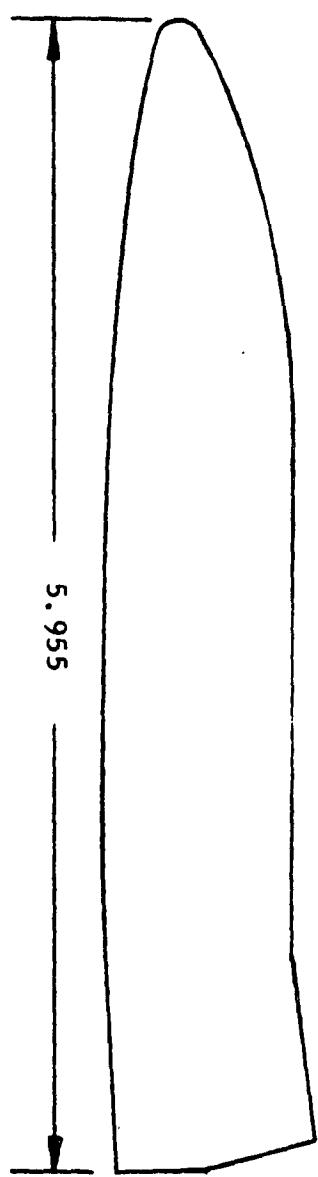


FIGURE F.  
BODY - B13

FIGURE G. BODY - B14



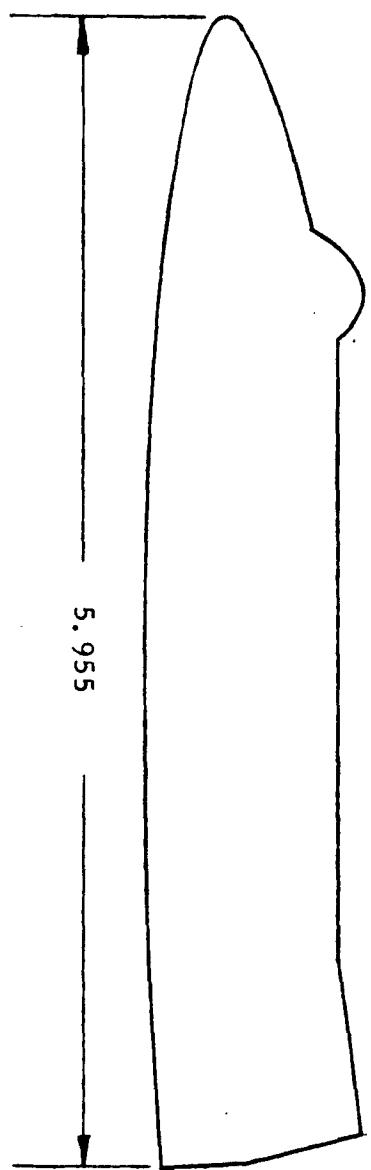


FIGURE H. BODY - B14 + K3

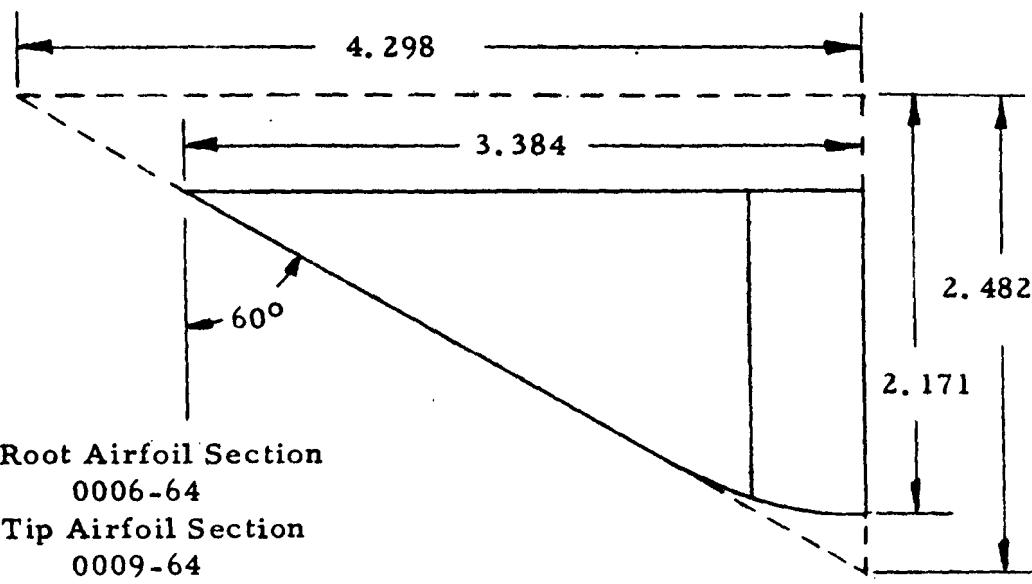


FIGURE I. WING - W26

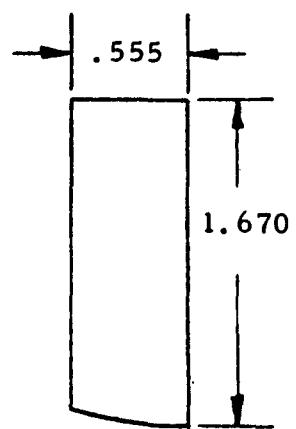


FIGURE J. ELEVON - E16

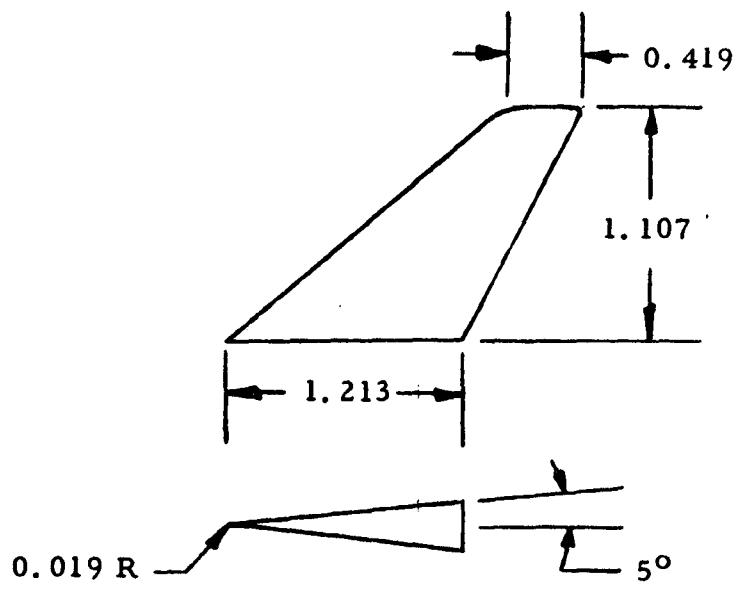


FIGURE K. VERTICAL TAIL - V36

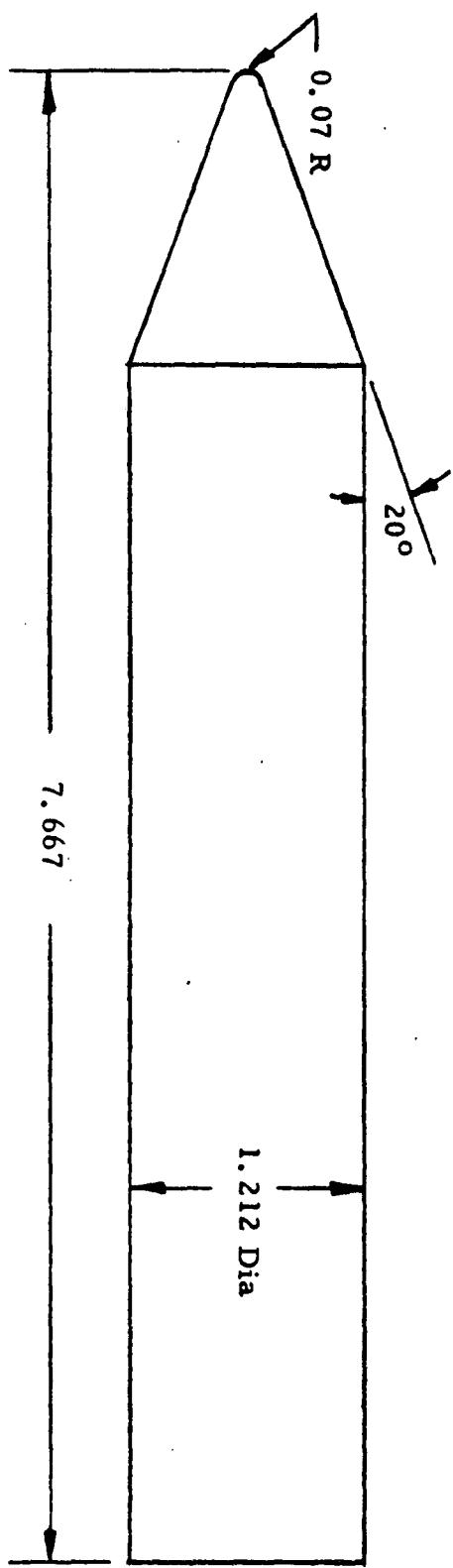
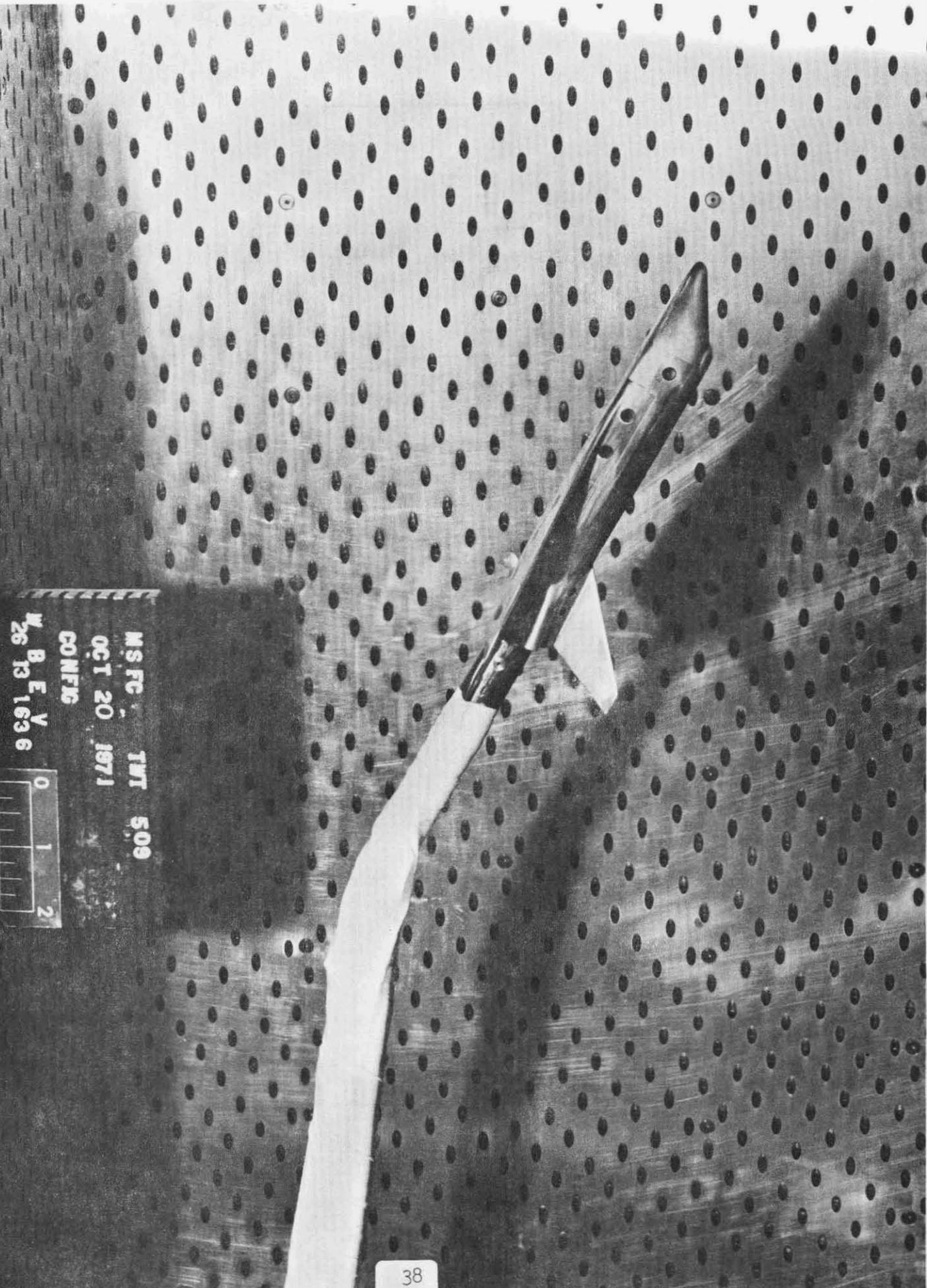


FIGURE L. TANK - T2

FIGURE M. TYPICAL MODEL INSTALLATION FOR HIGH ANGLE OF ATTACK TESTING

MSFC TWT 509  
OCT 20 1971  
CONFIG  
 $\psi_{26}$  B E V 6  
13 163 6



Reproduced from  
best available  
copy.

Notes:

- Positive directions of force coefficients moment coefficients, and angles are indicated by arrows.
- For clarity, origins of wind and stability axes have been displaced from the center of gravity.

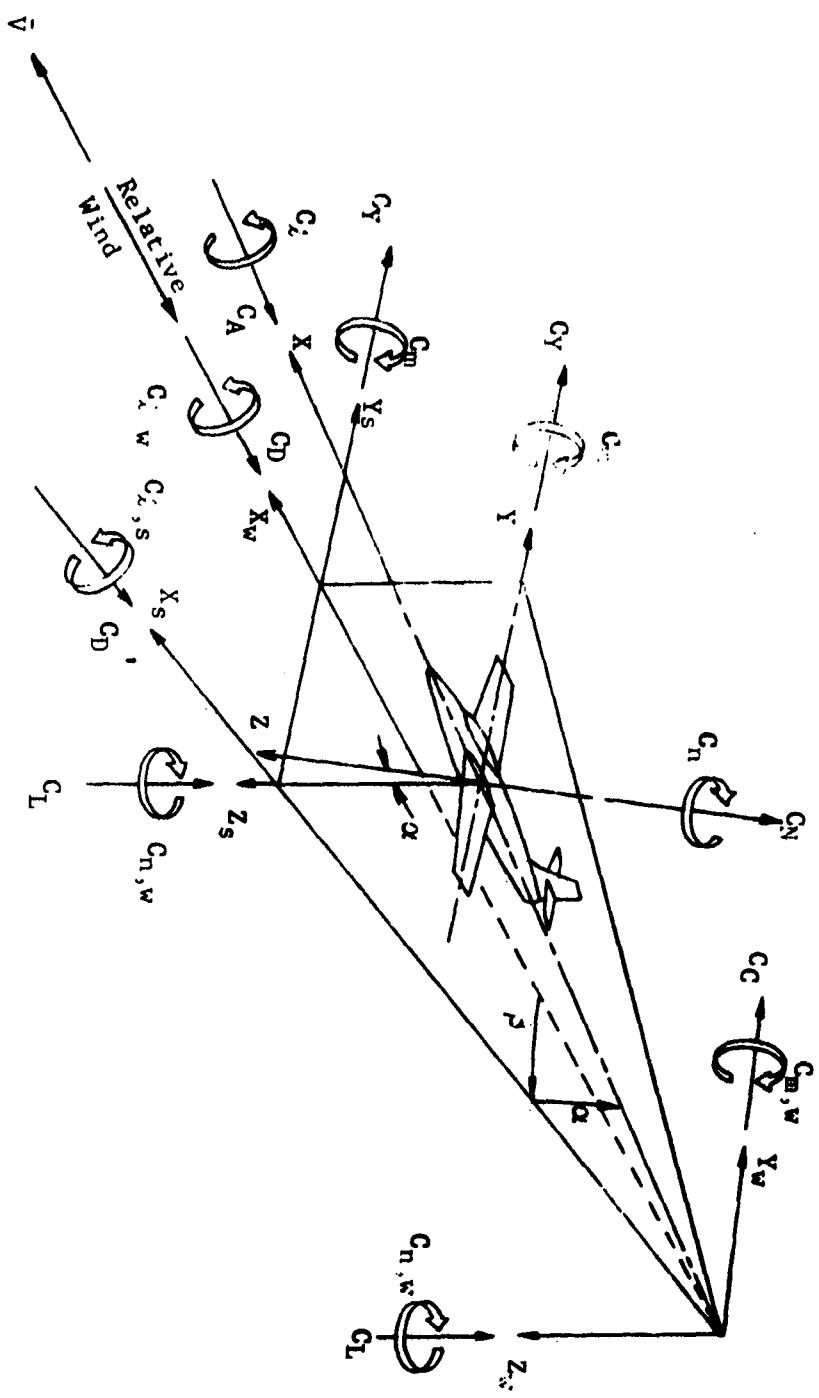
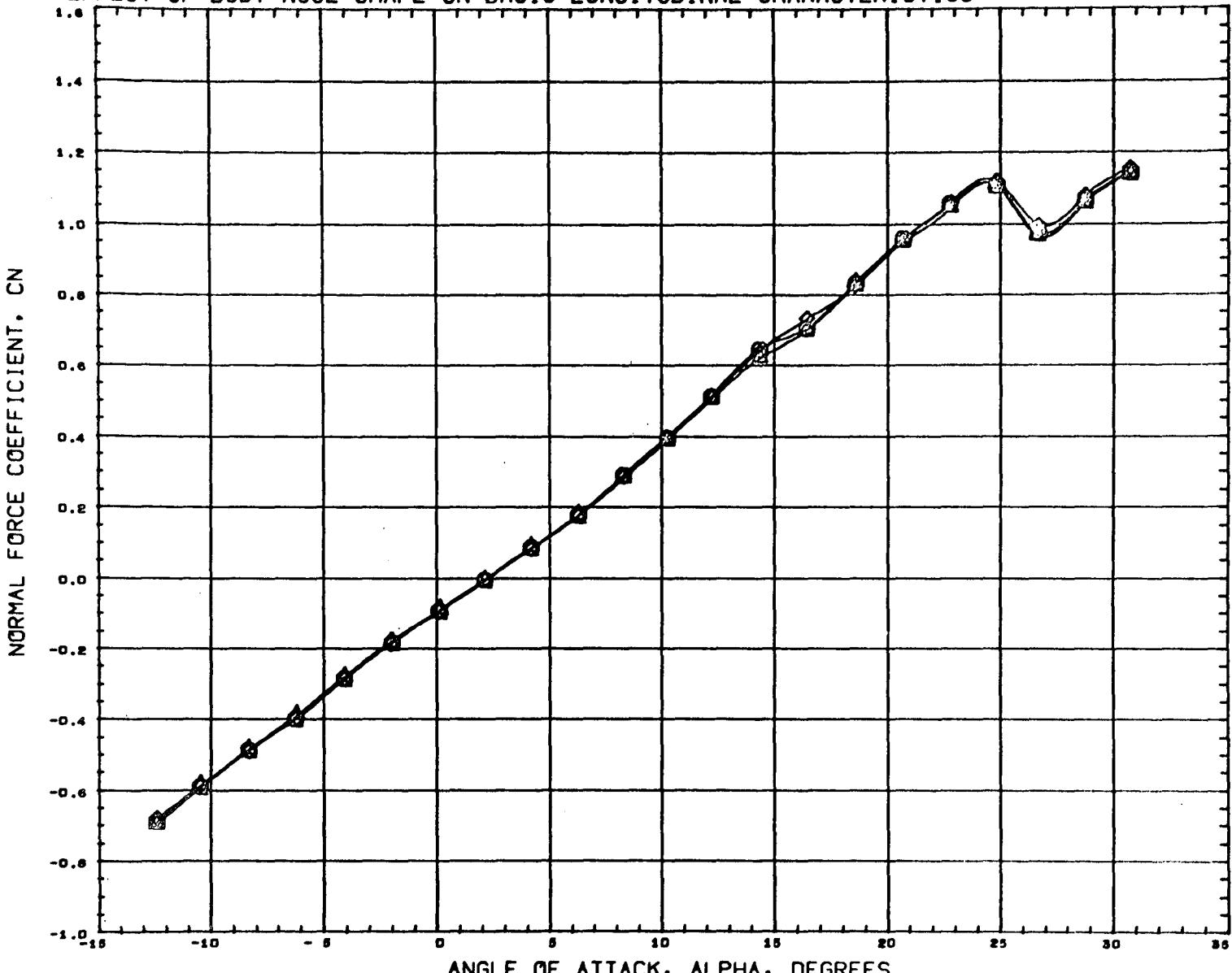


FIGURE N. Axis systems, showing direction and sense of force and moment coefficients, angle of attack, and sideslip angle

D A T A      F I G U R E S

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (C91018) MSFC509 NR 110C ORBITER B12W26E16V36  
 (C91038) MSFC509 NR 110C ORBITER B13W26E16V36  
 (C91048) MSFC509 NR 110C ORBITER B14K3W26E16V36

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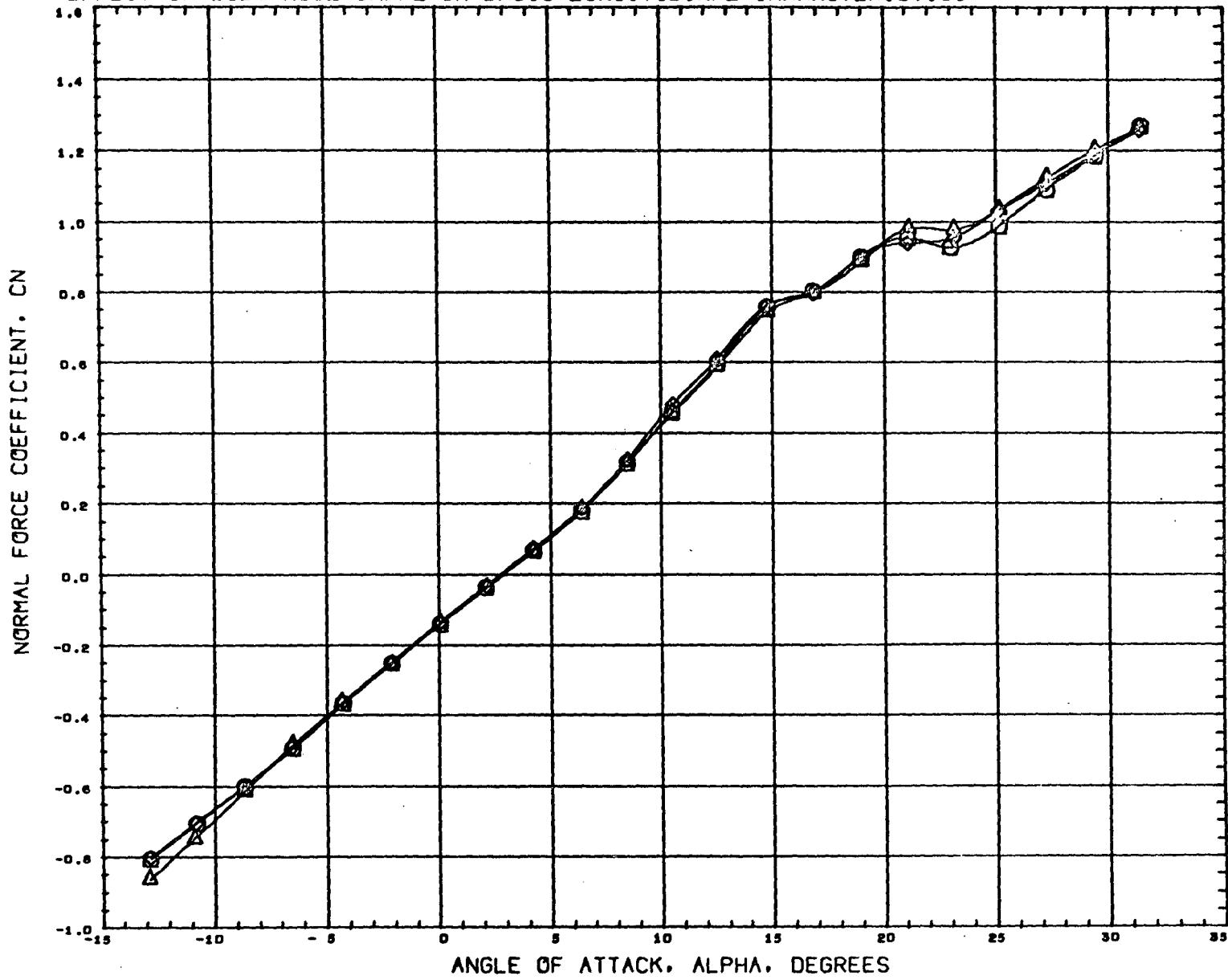
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 XMRP 3.6080 INCHES  
 YMRP 0.0000 INCHES  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.605

PAGE

1

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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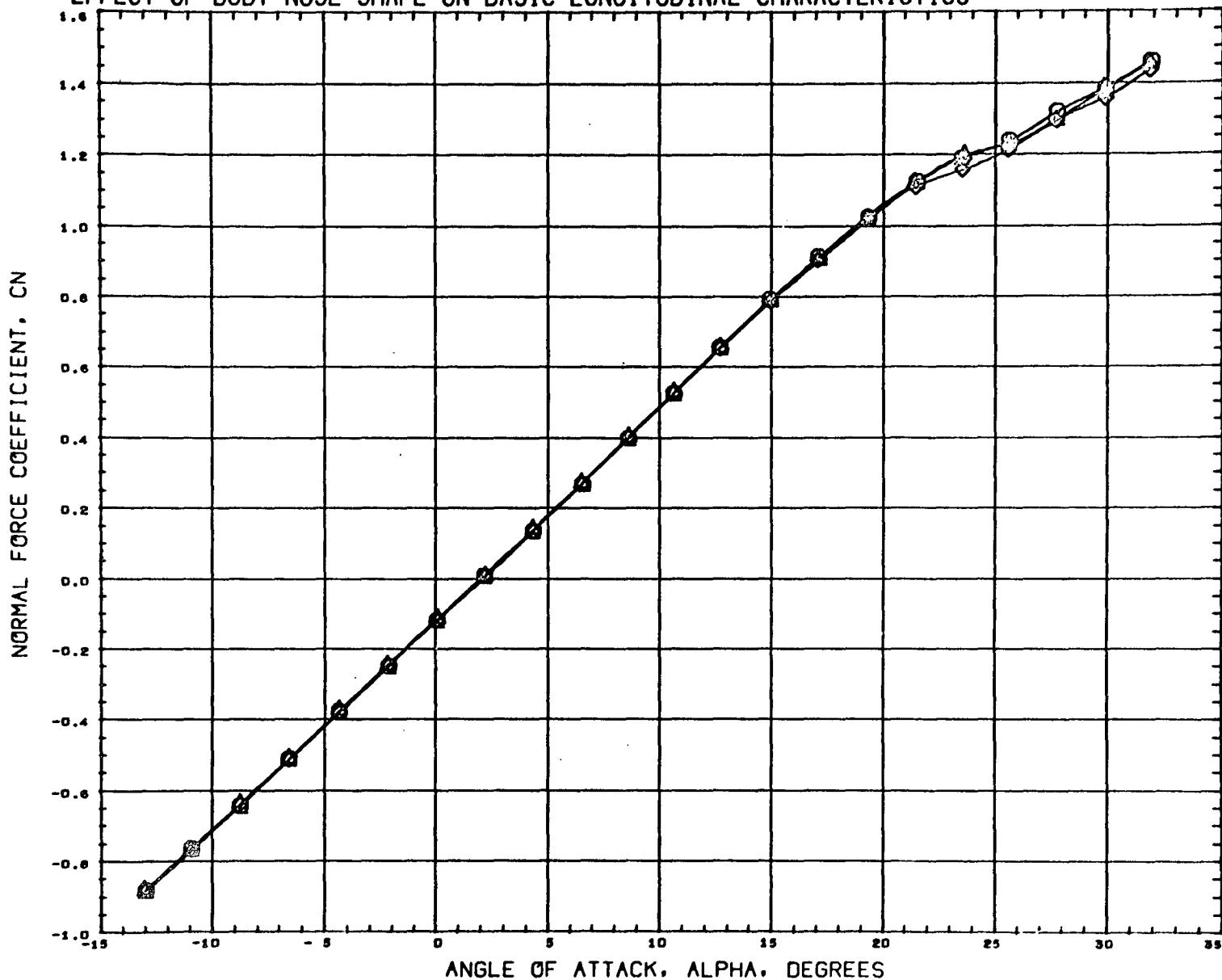
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MACH 0.898

PAGE 2

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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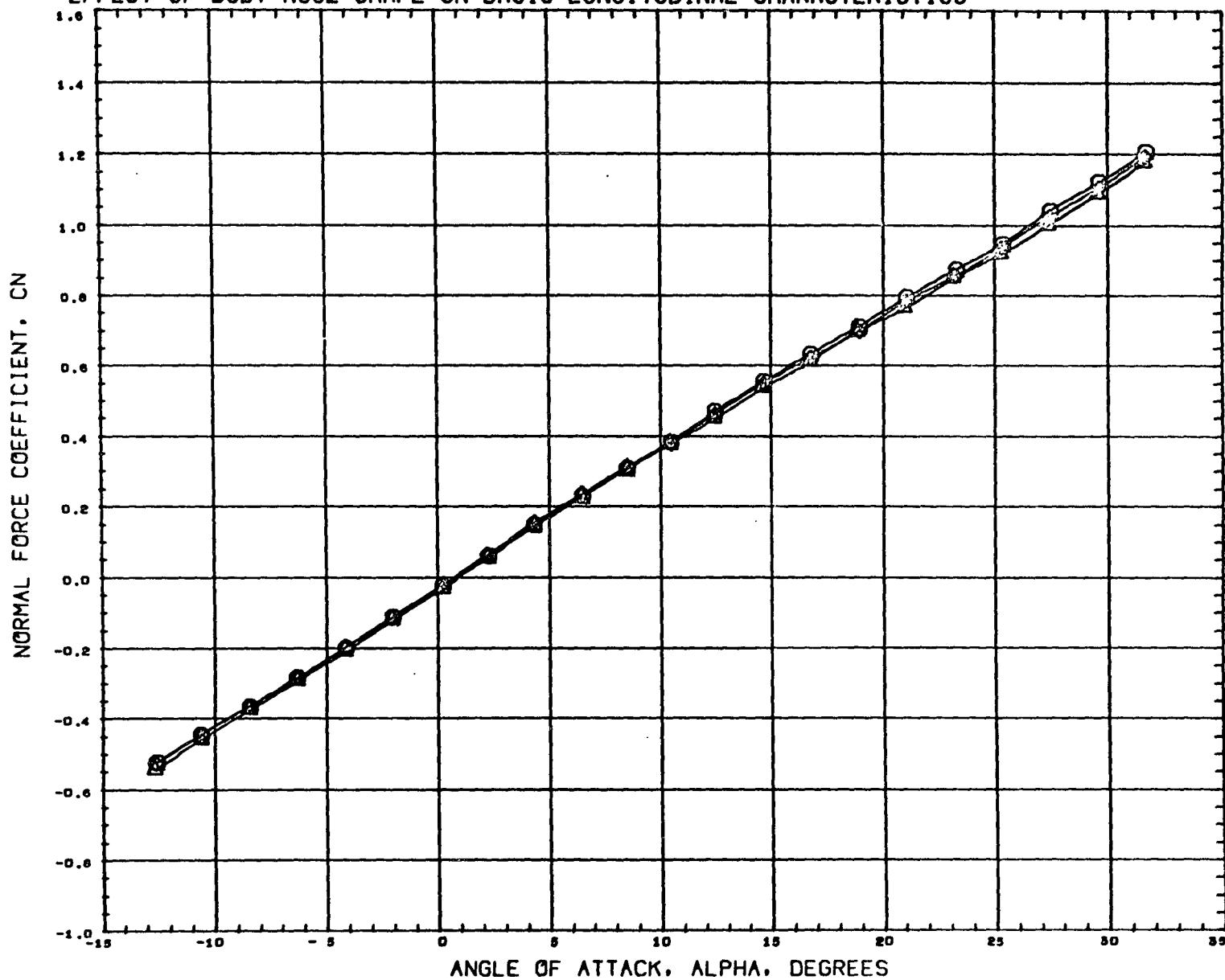
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 YMRP 0.0000 INCHES  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.194

PAGE 3

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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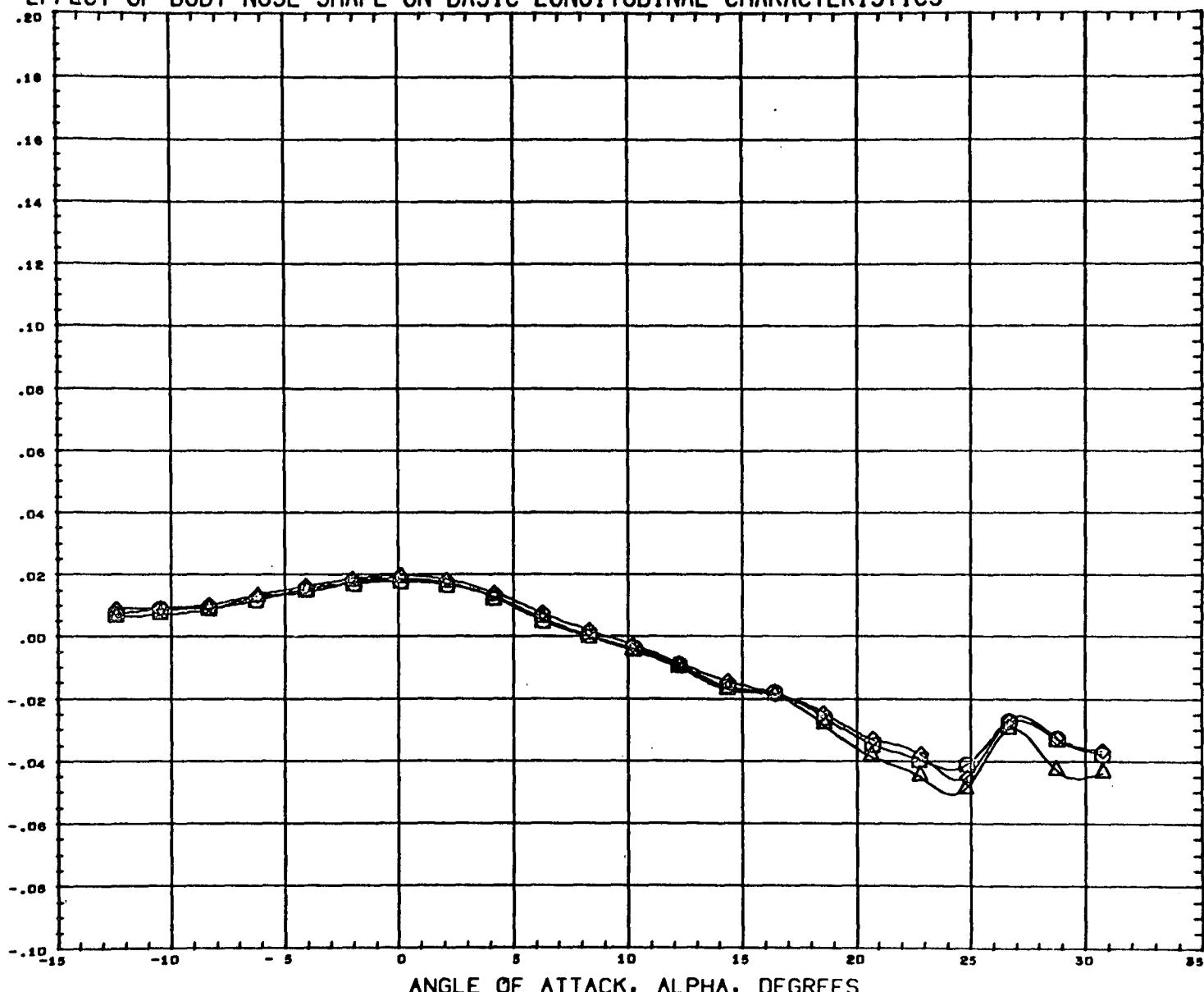
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.961

PAGE 4

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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 (C51038) MSFC509 NR 11OC ORBITER B13W26E16V36  
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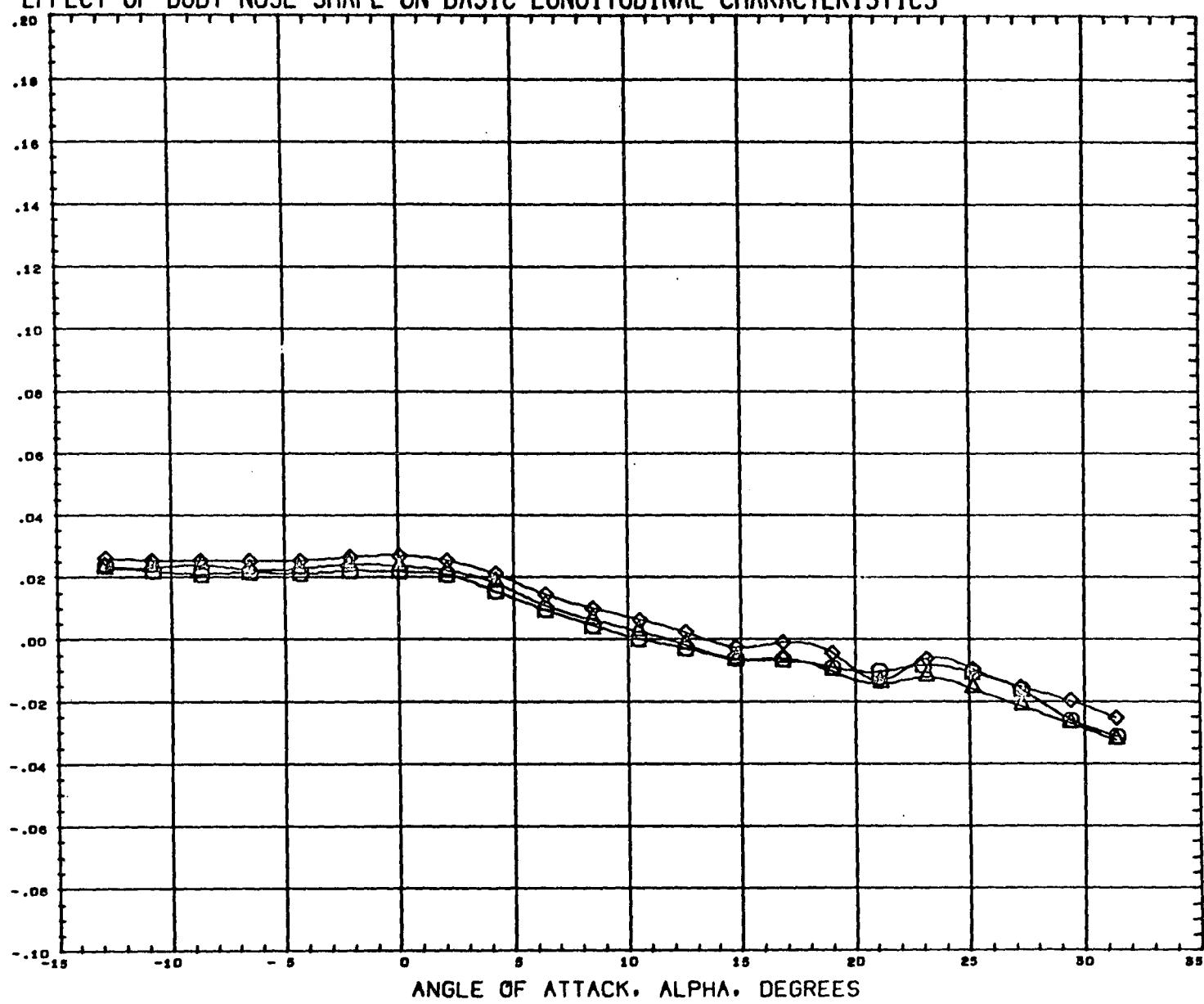
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 YMRP 0.0000  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.605

PAGE 5

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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 (C51D38) MSFC509 NR 11OC ORBITER B13W26E16V36  
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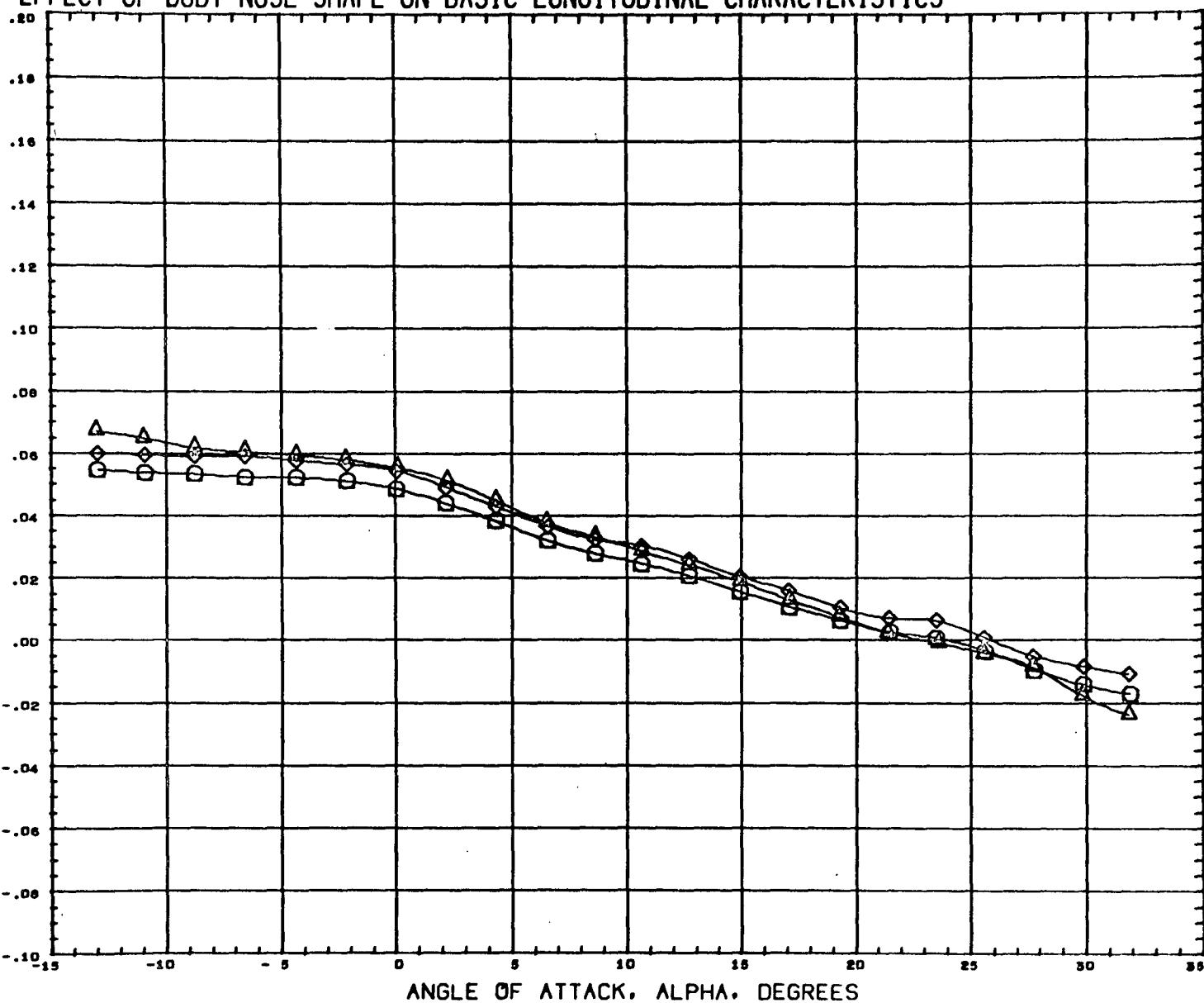
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 YMRP 0.0000 INCHES  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.696

PAGE 6

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (C5101S) MSFC509 NR 11OC ORBITER B12W26E16V36  
 (C5103S) MSFC509 NR 11OC ORBITER B13W26E16V36  
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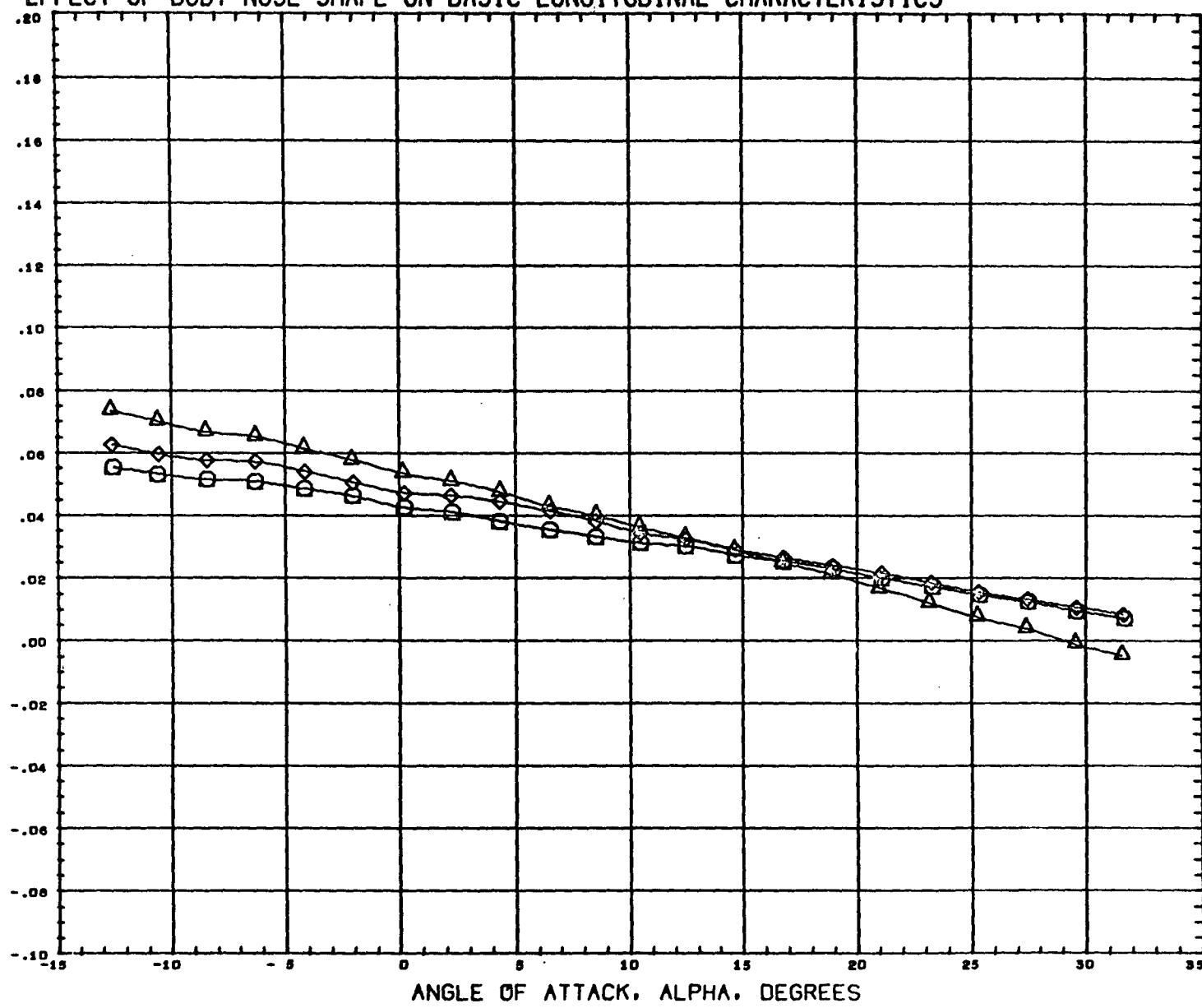
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 YMRP 0.0000  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.194

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## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(CS1018) MSFC509 NR 110C ORBITER B12W26E16V36  
 (CS1038) MSFC509 NR 110C ORBITER B13W26E16V36  
 (CS1048) MSFC509 NR 110C ORBITER B14K3W26E16V36

BETA

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0.000  
0.000

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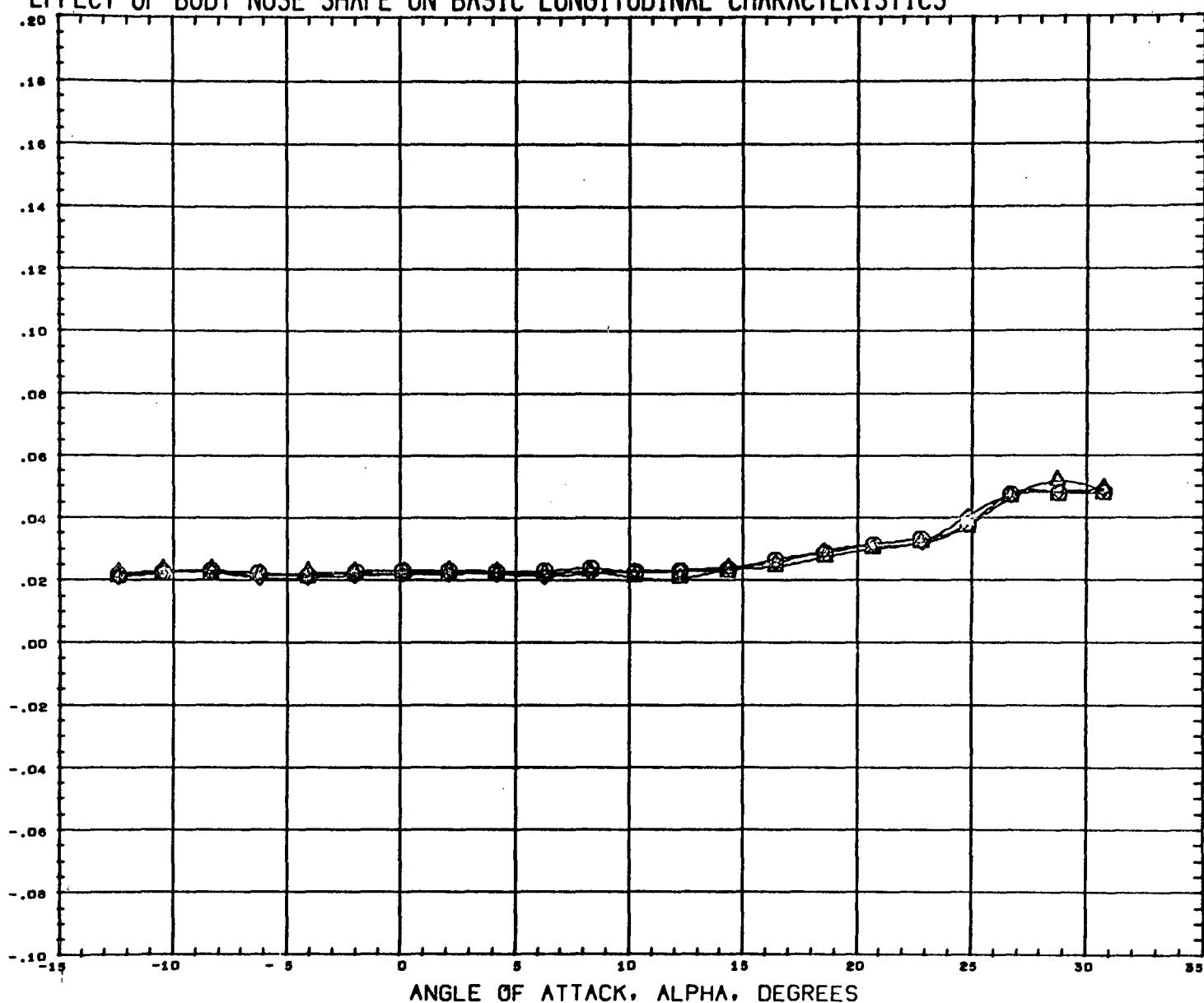
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PAGE

8

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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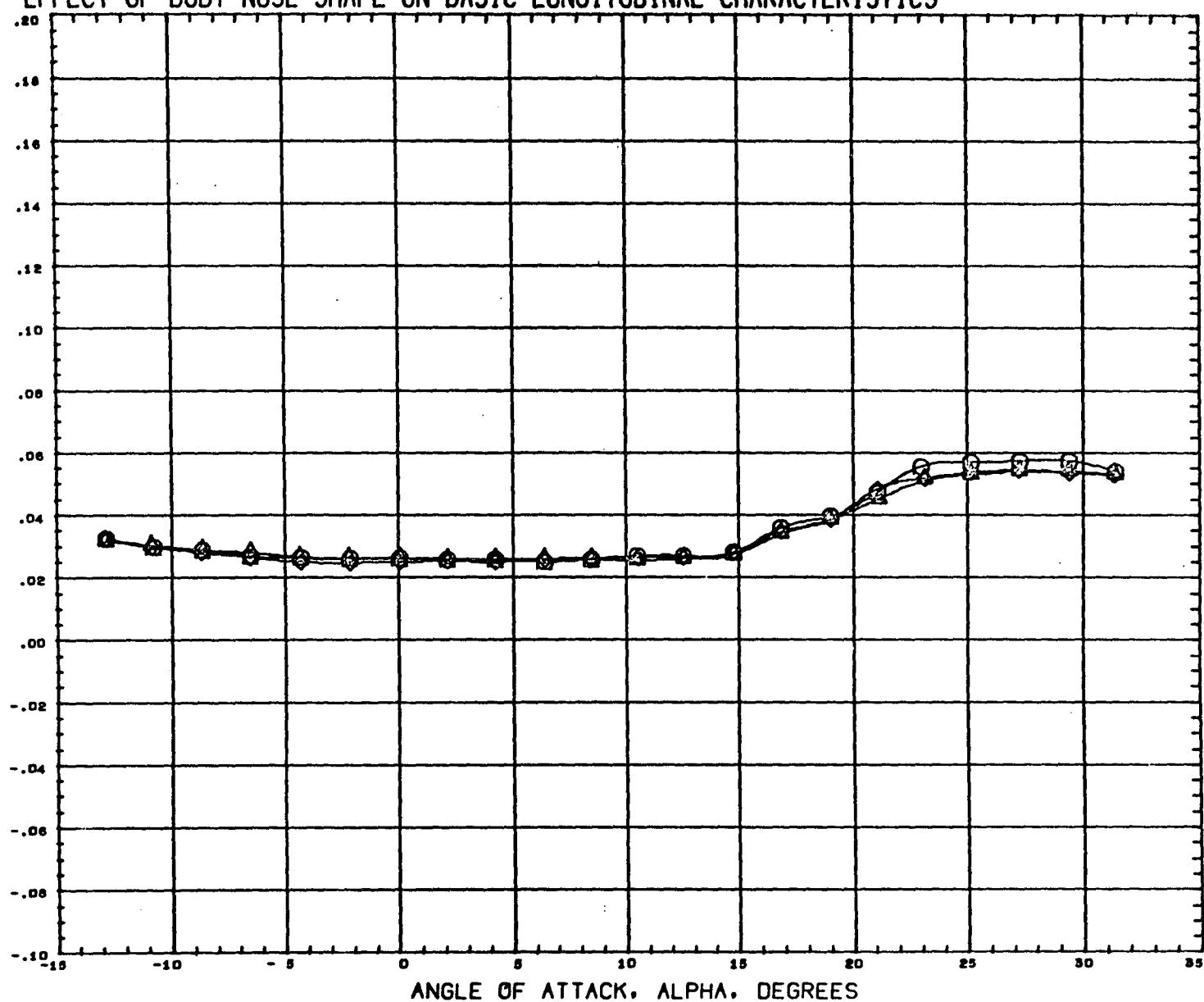
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 SCALE 0.0044 SCALE

MACH 0.605

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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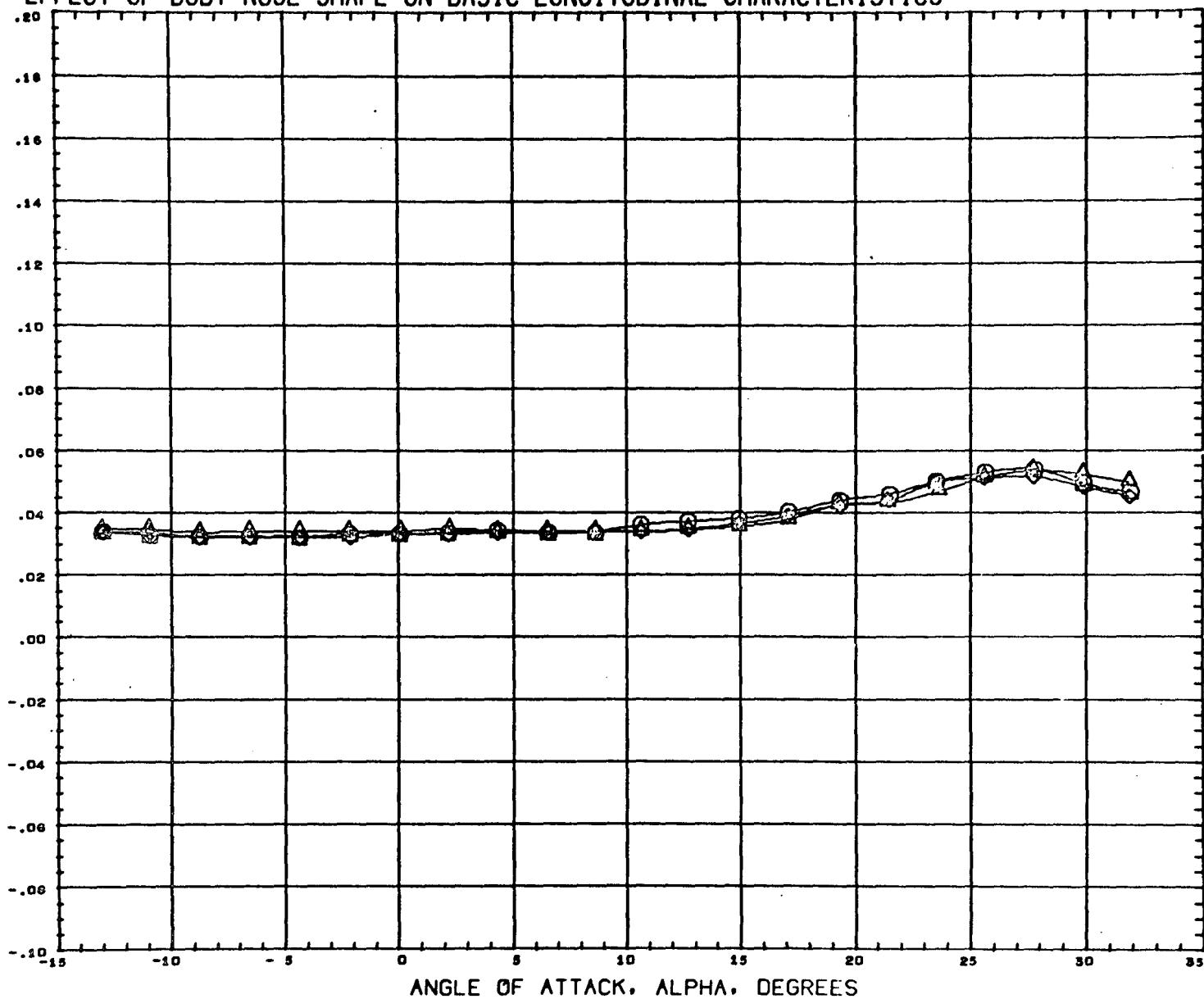
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MACH 0.696

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



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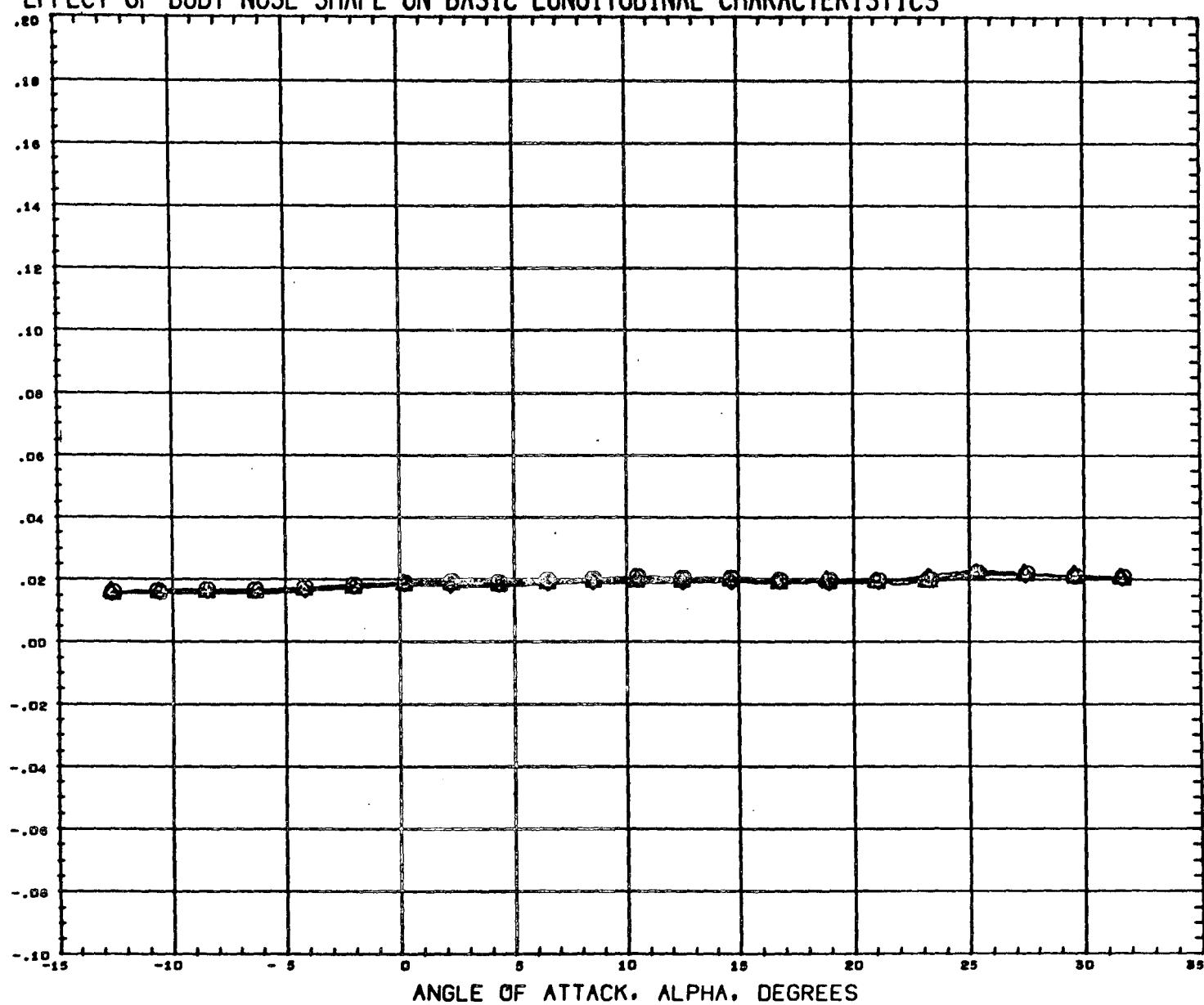
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MACH 1.194

PAGE 11

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(C51018) M8FC509 NR 11OC ORBITER B12W26E16V36  
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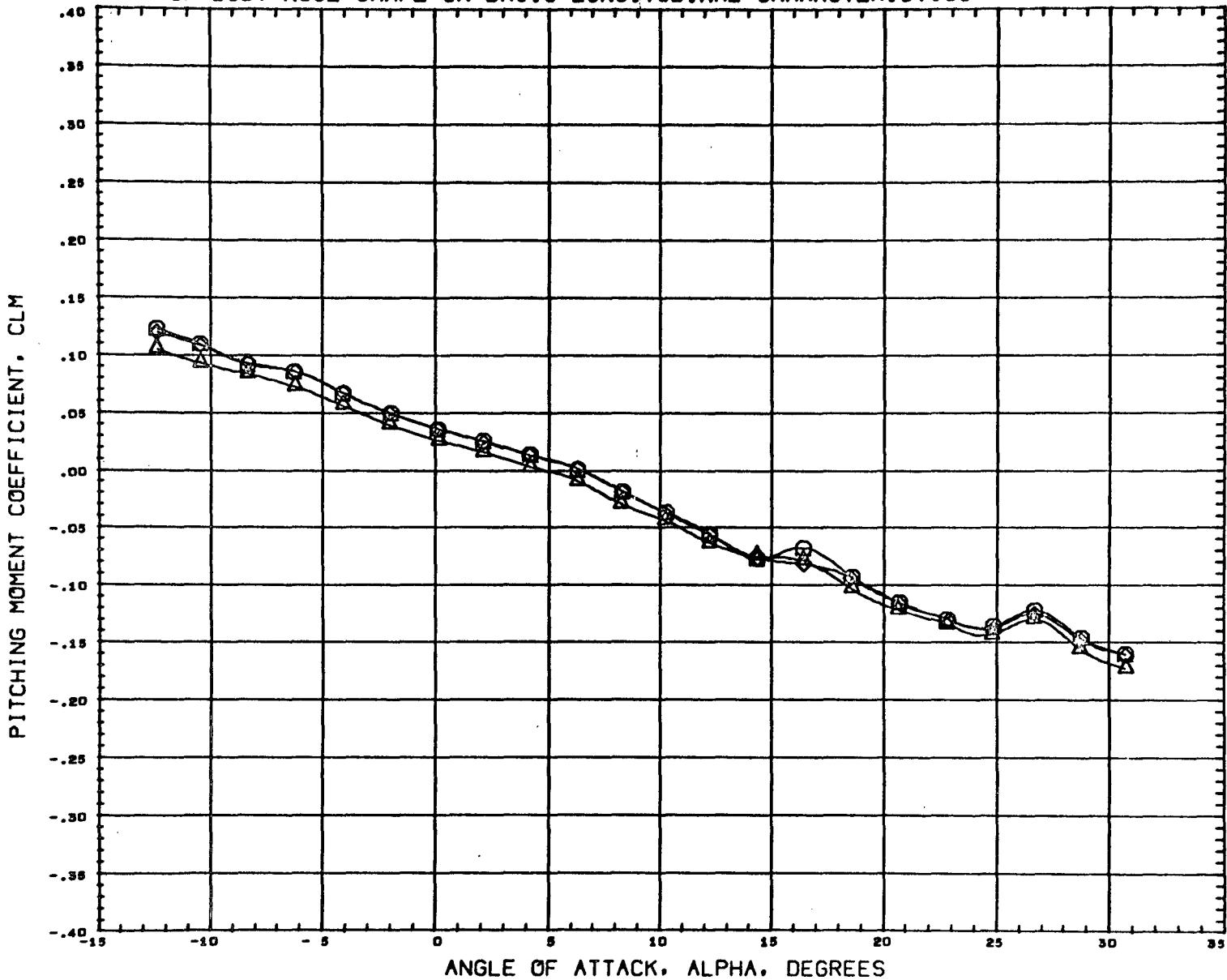
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MACH 1.961

PAGE 12

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



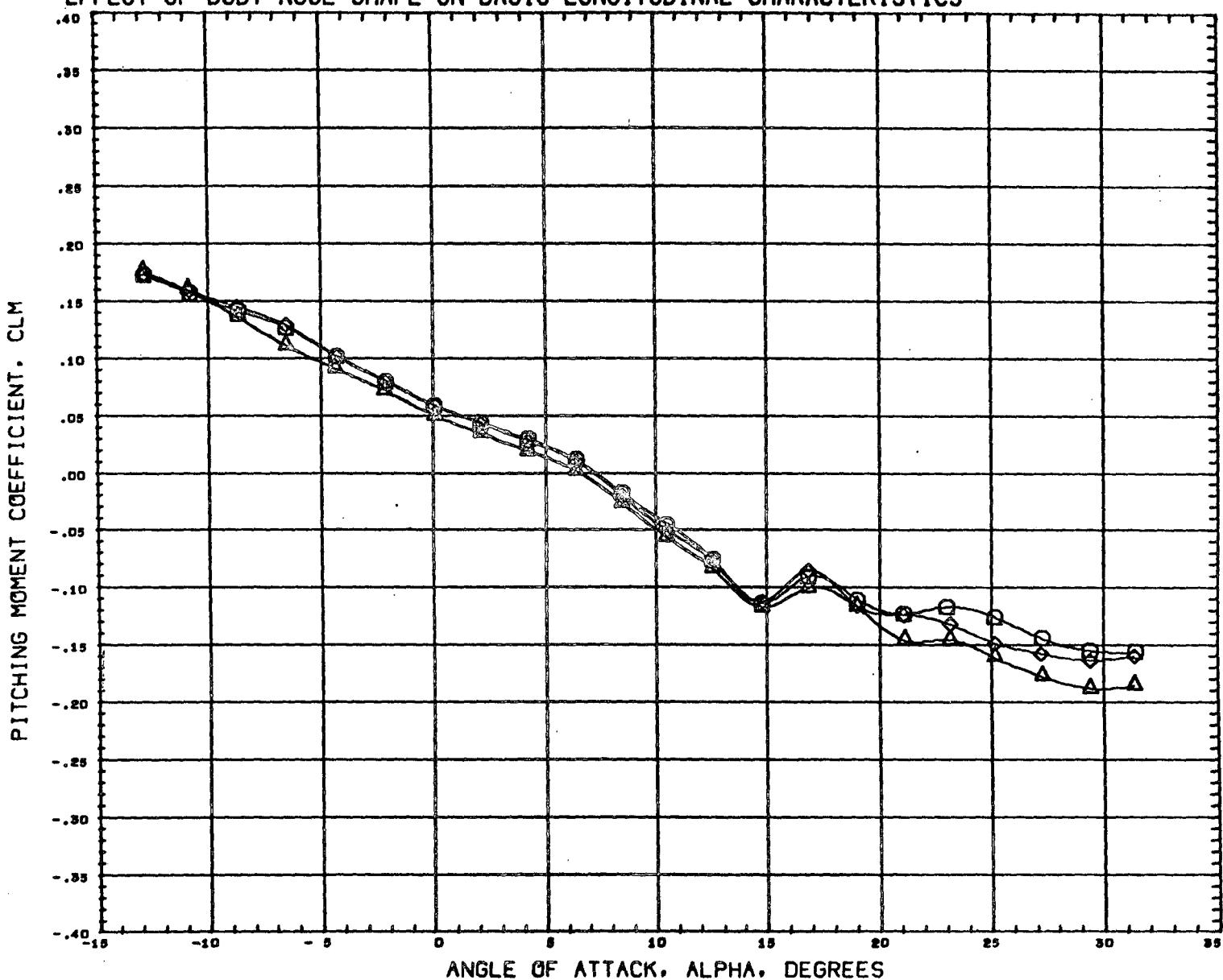
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MACH 0.605

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



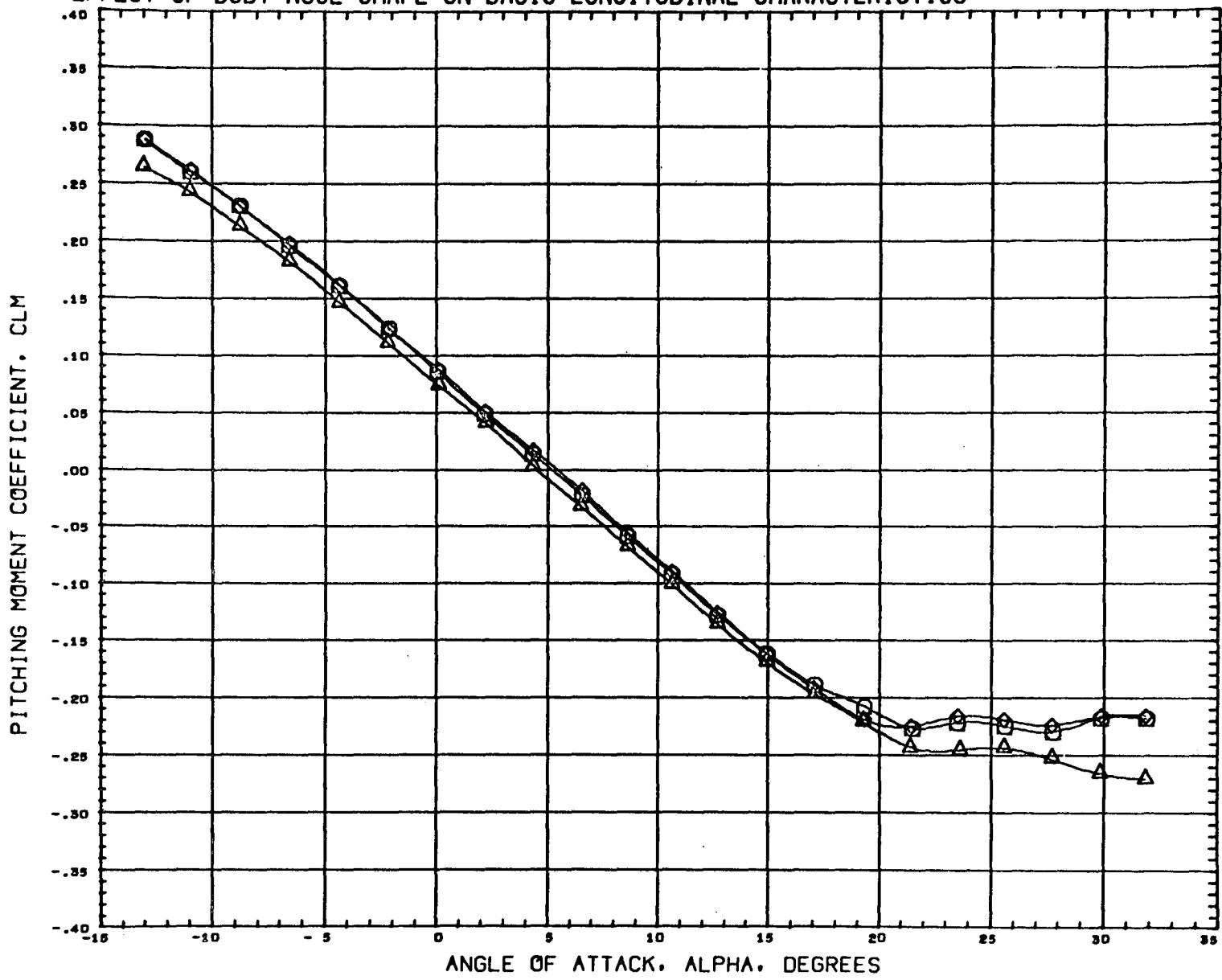
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MACH 0.896

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



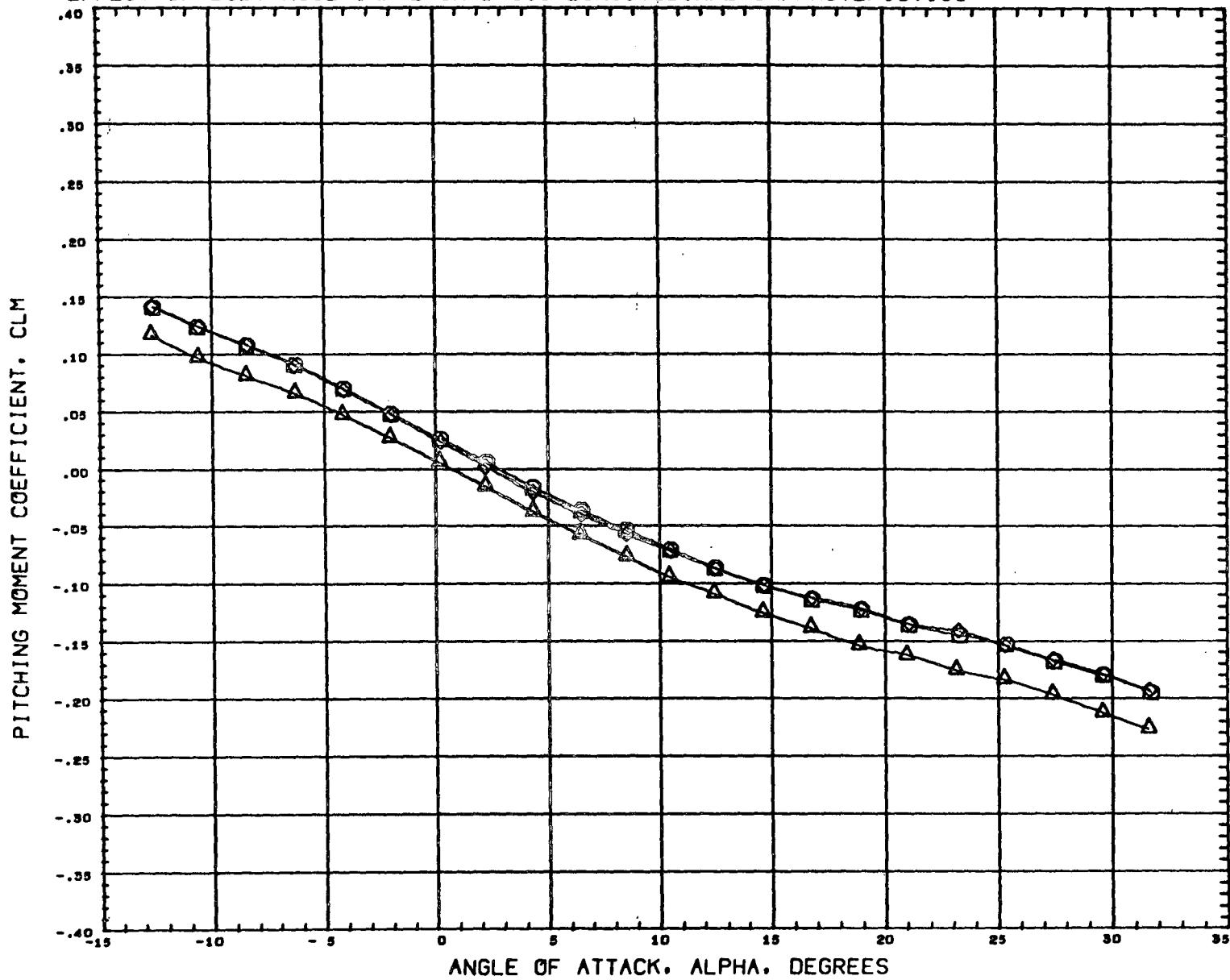
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MACH 1.194

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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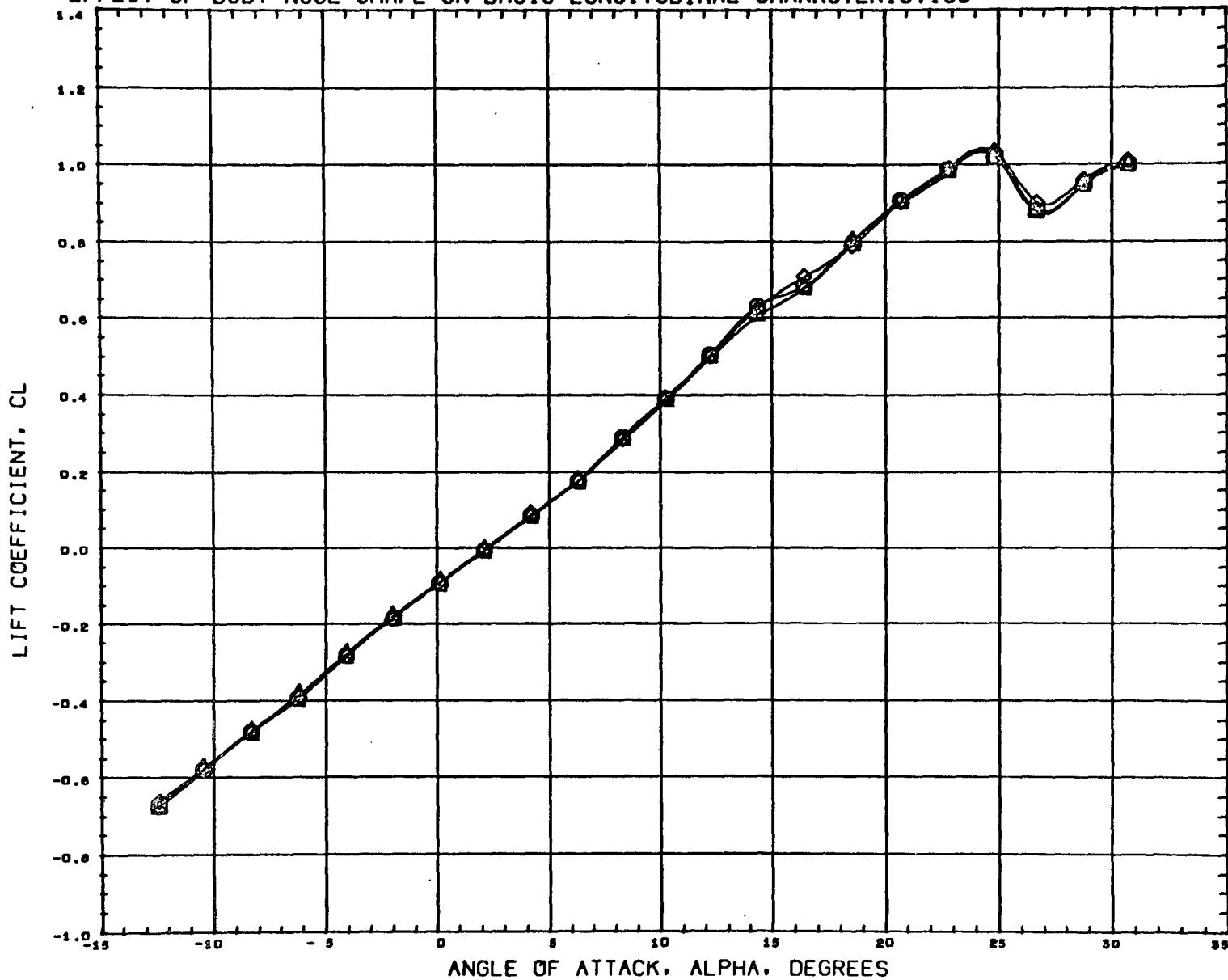
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MACH 1.961

PAGE 16

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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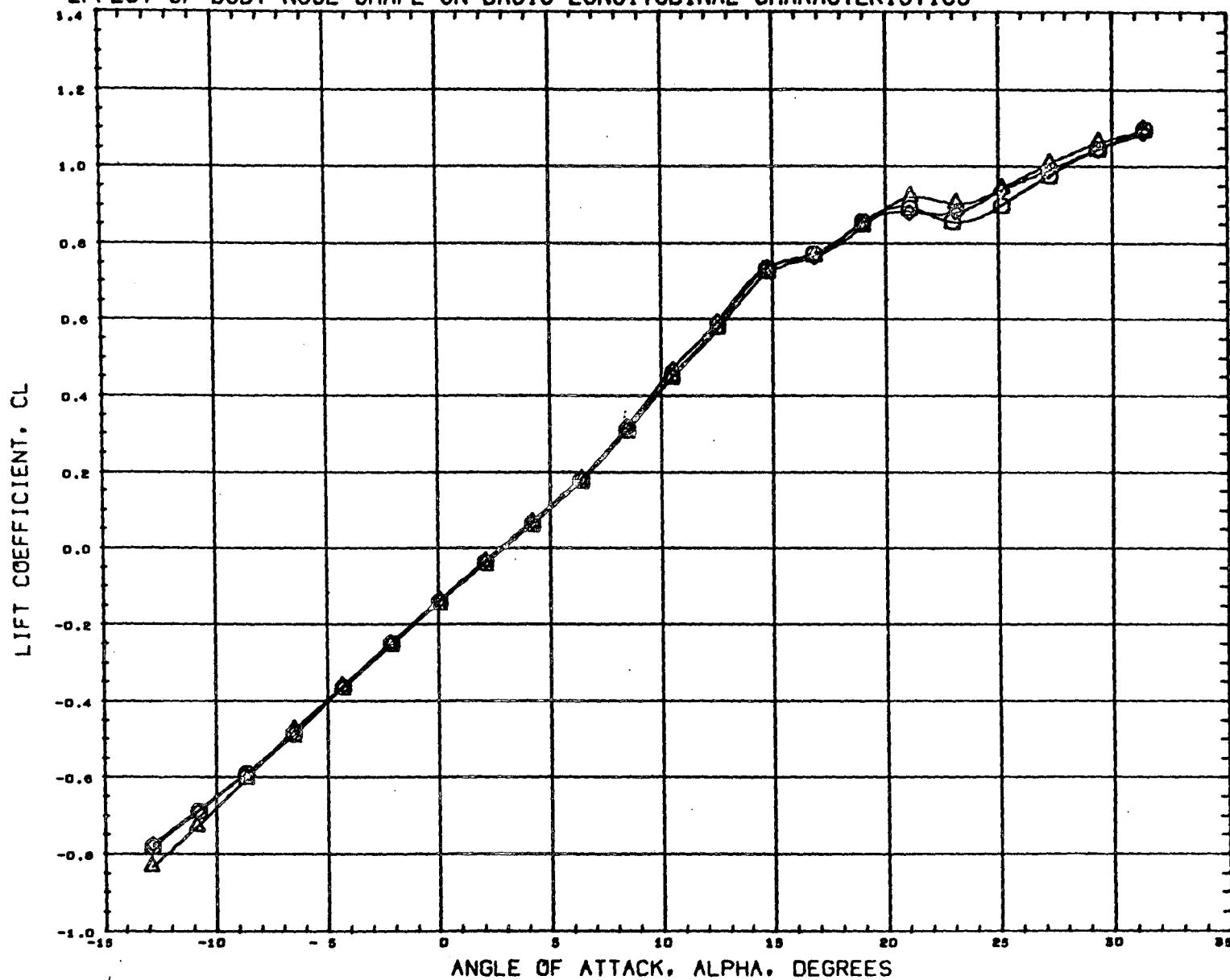
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MACH 0.605

PAGE 17

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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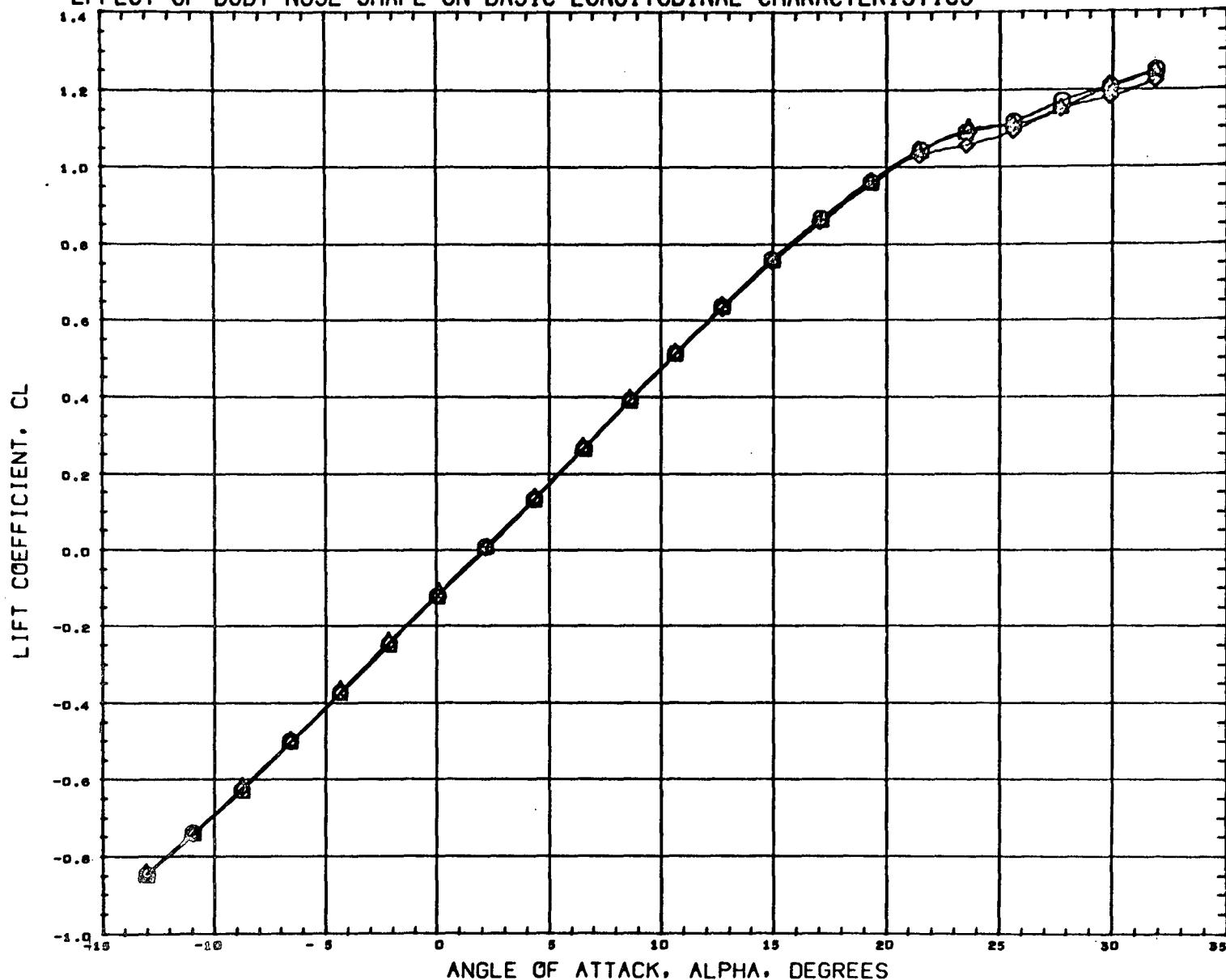
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MACH 0.898

PAGE 18

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



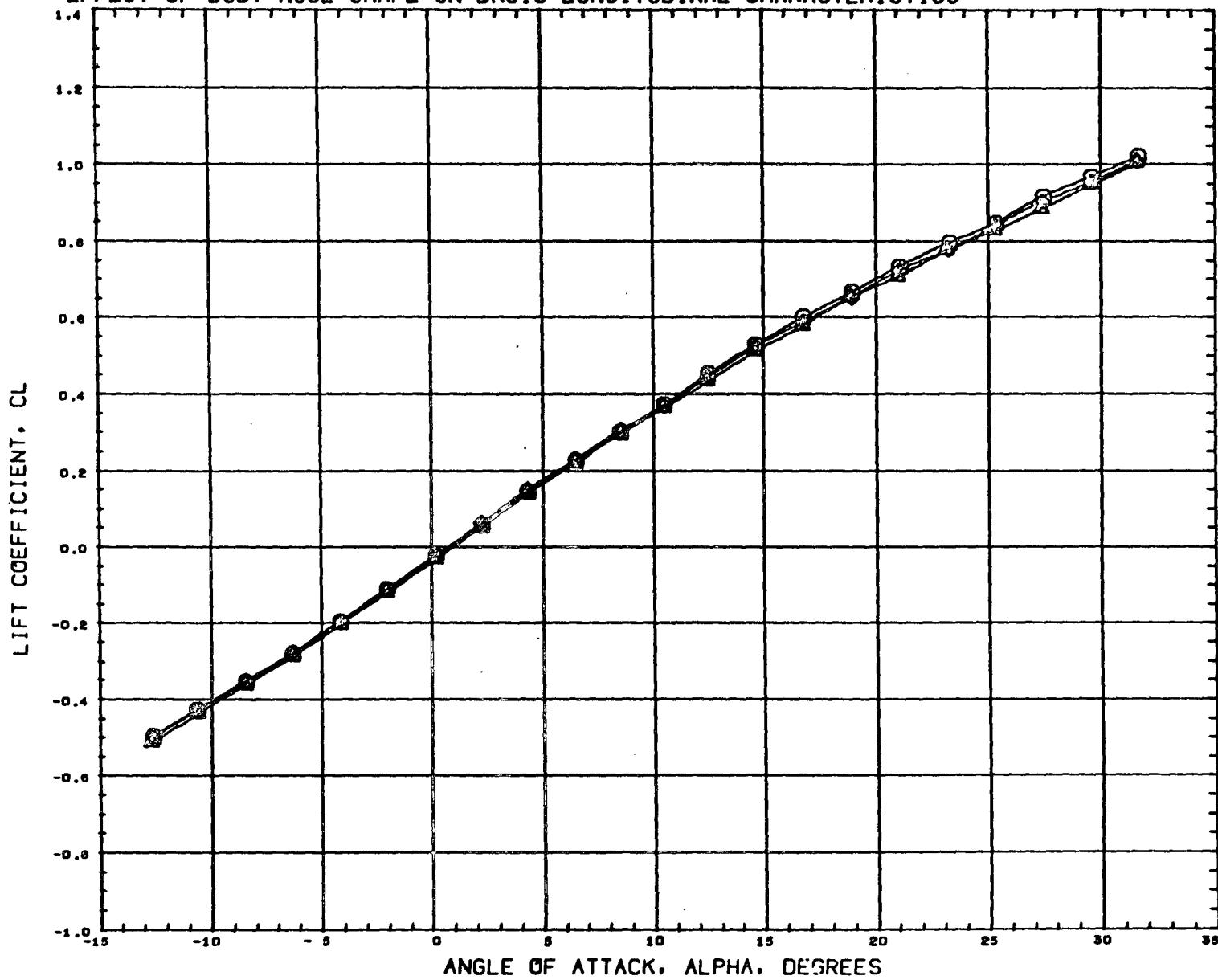
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MACH 1.194

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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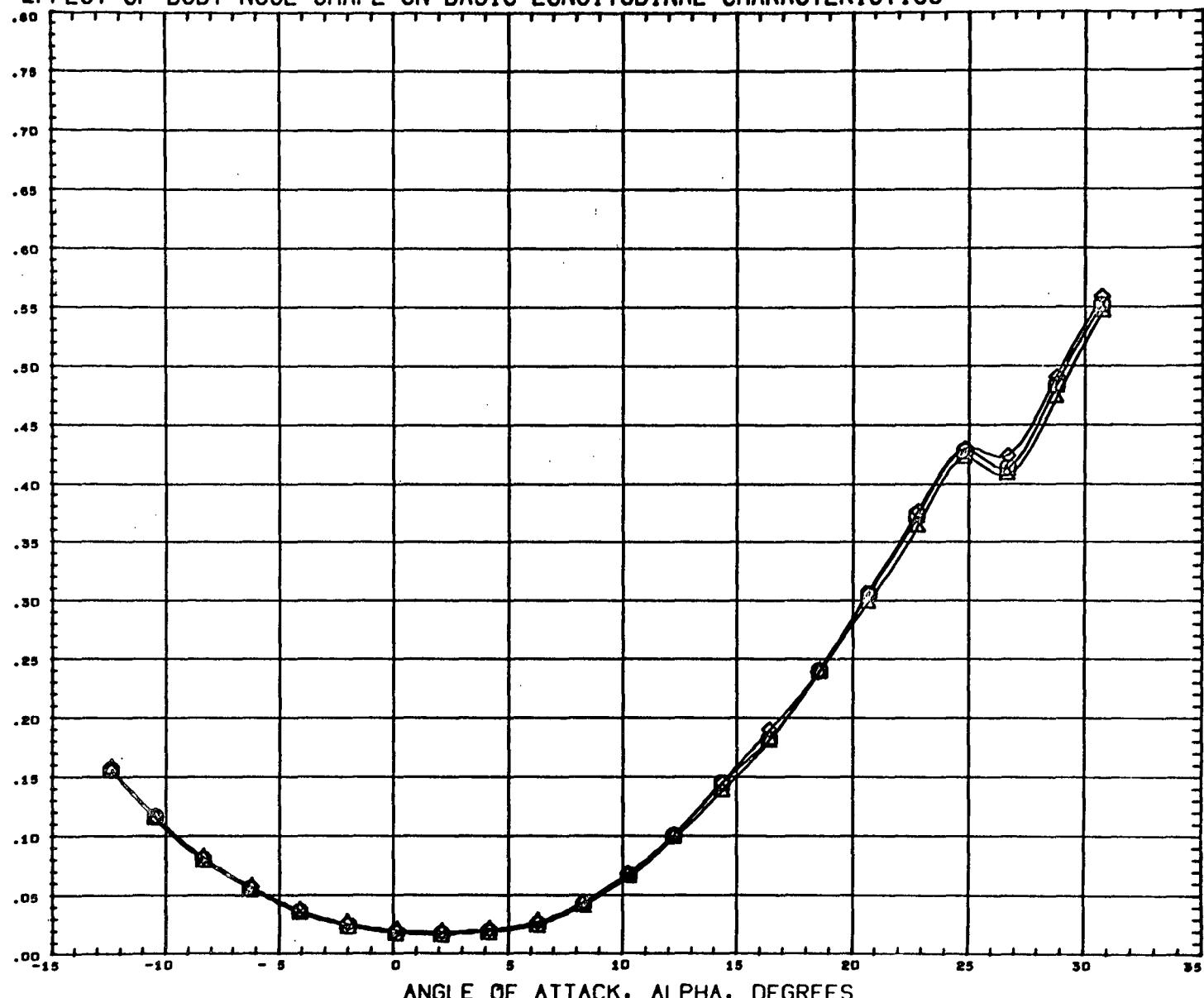
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MACH 1.061

PAGE 20

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, CDF



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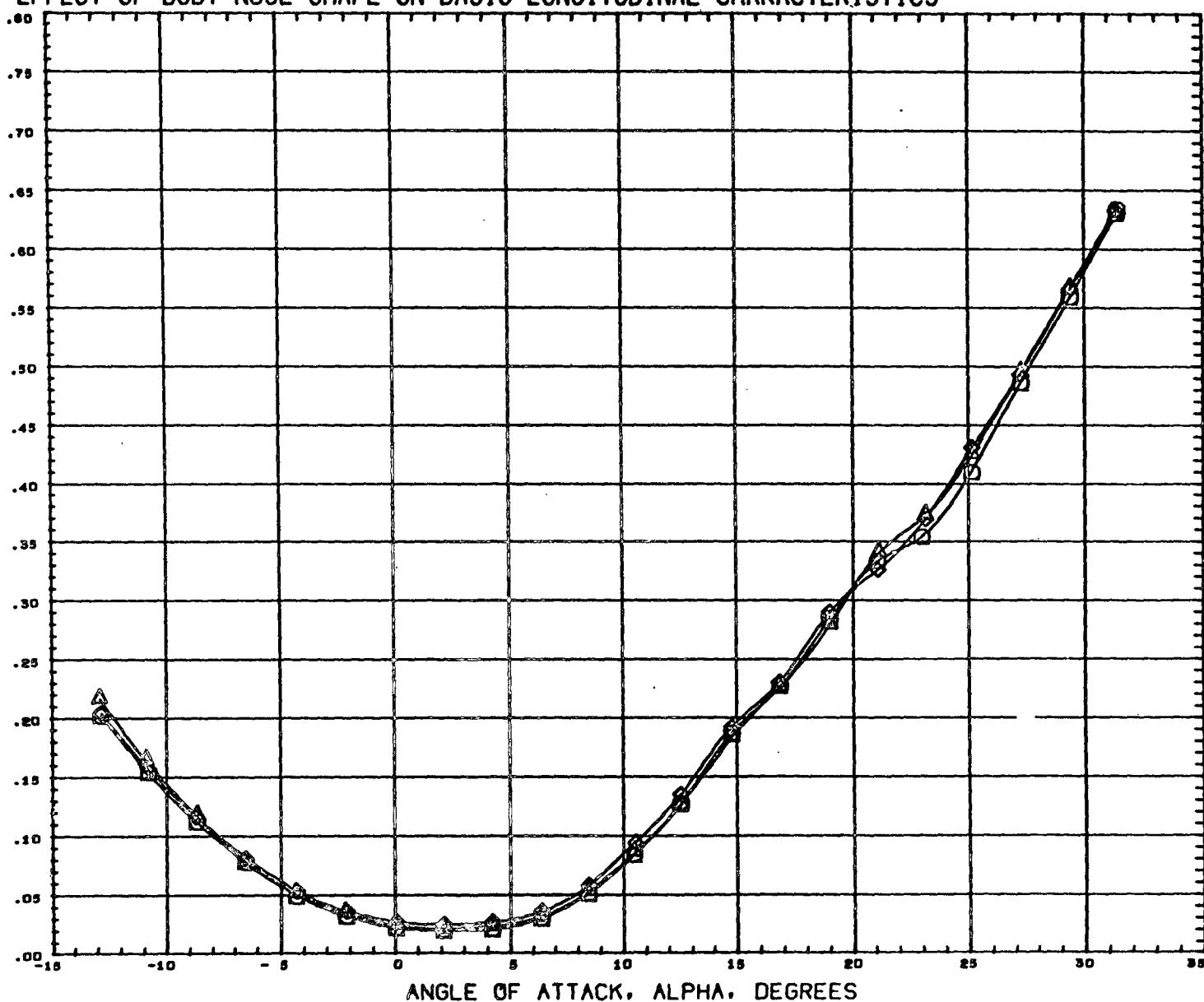
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MACH 0.605

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, CDF



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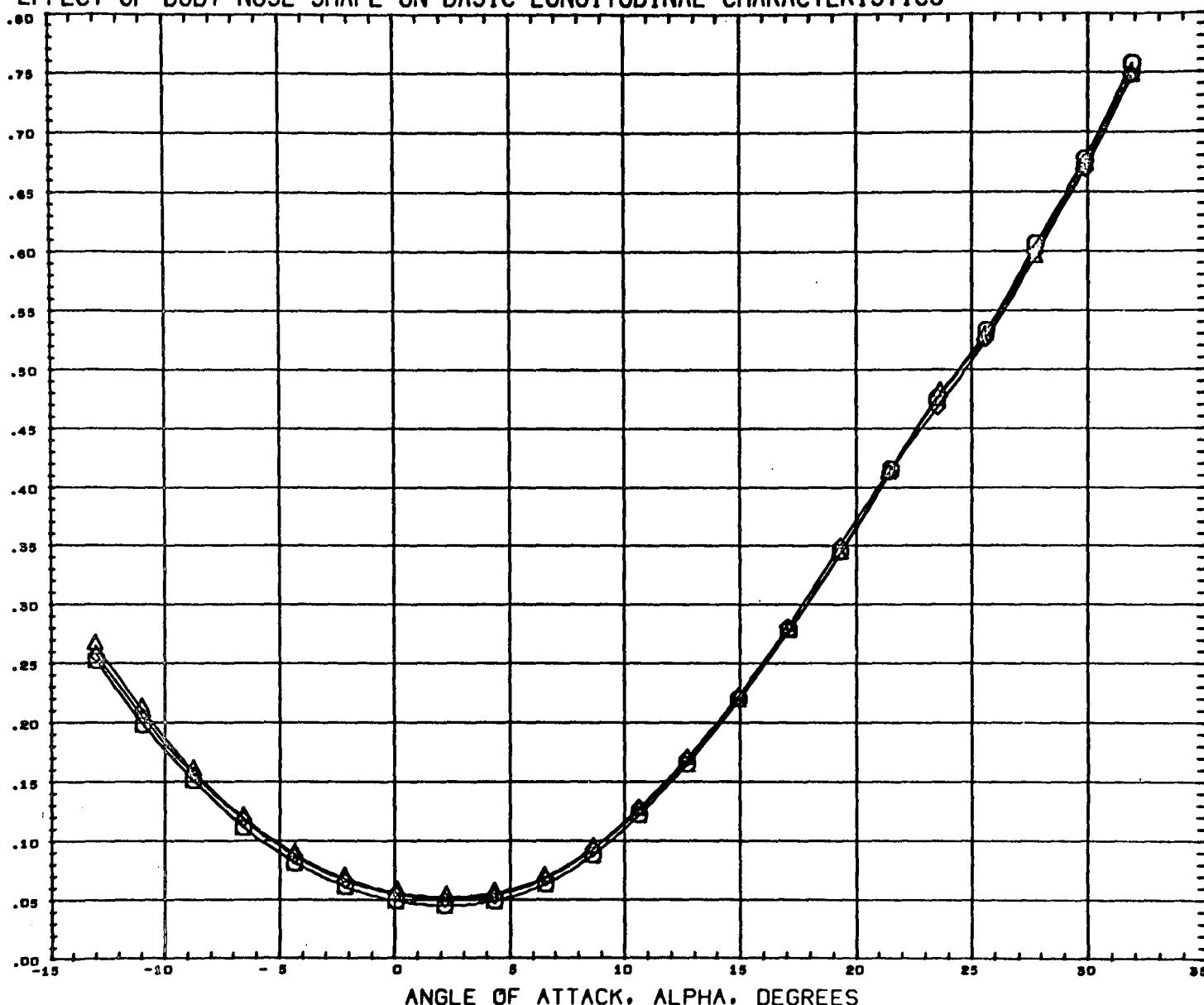
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MACH 0.698

PAGE 22

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT. CDF



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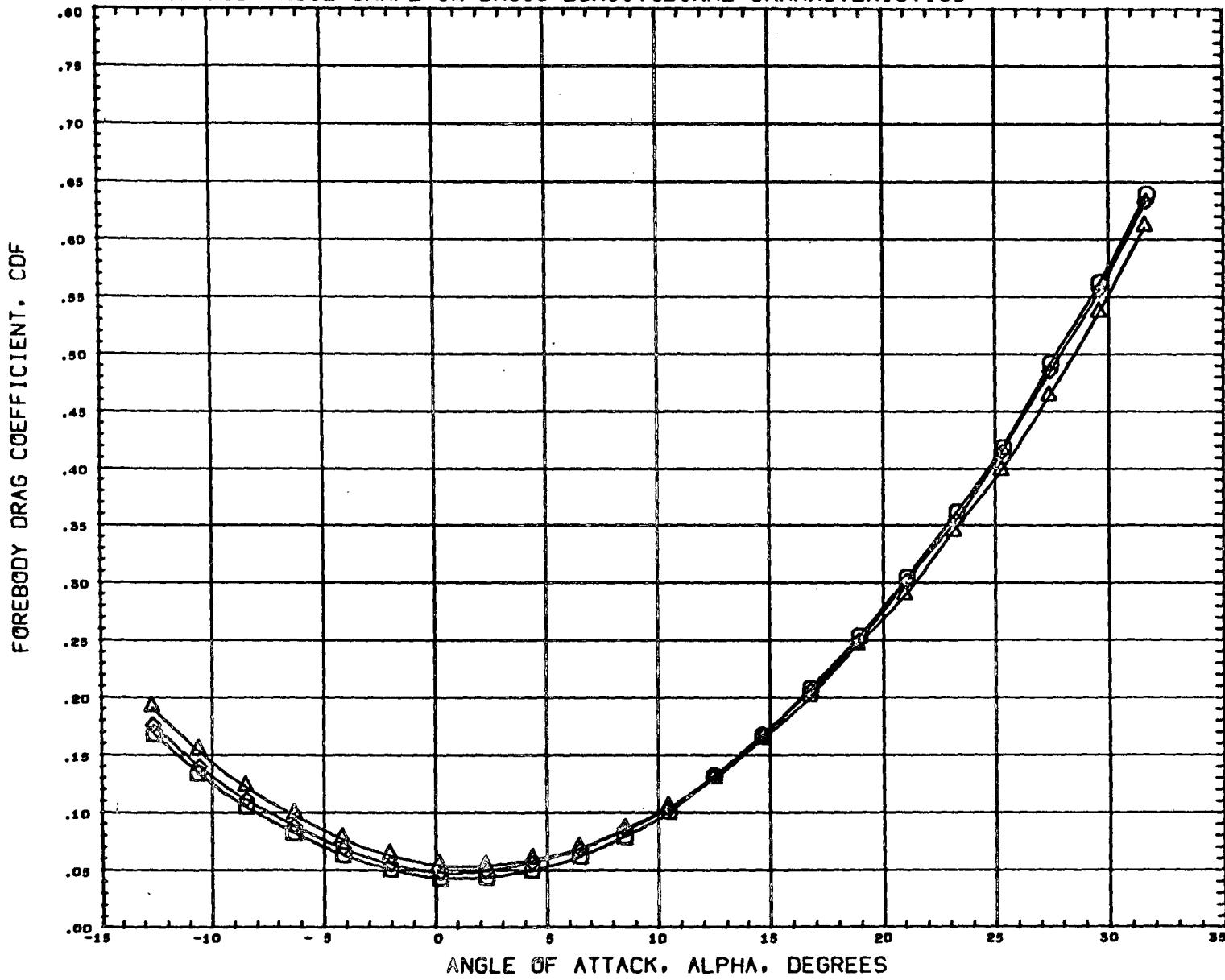
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MACH 1.194

PAGE 23

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



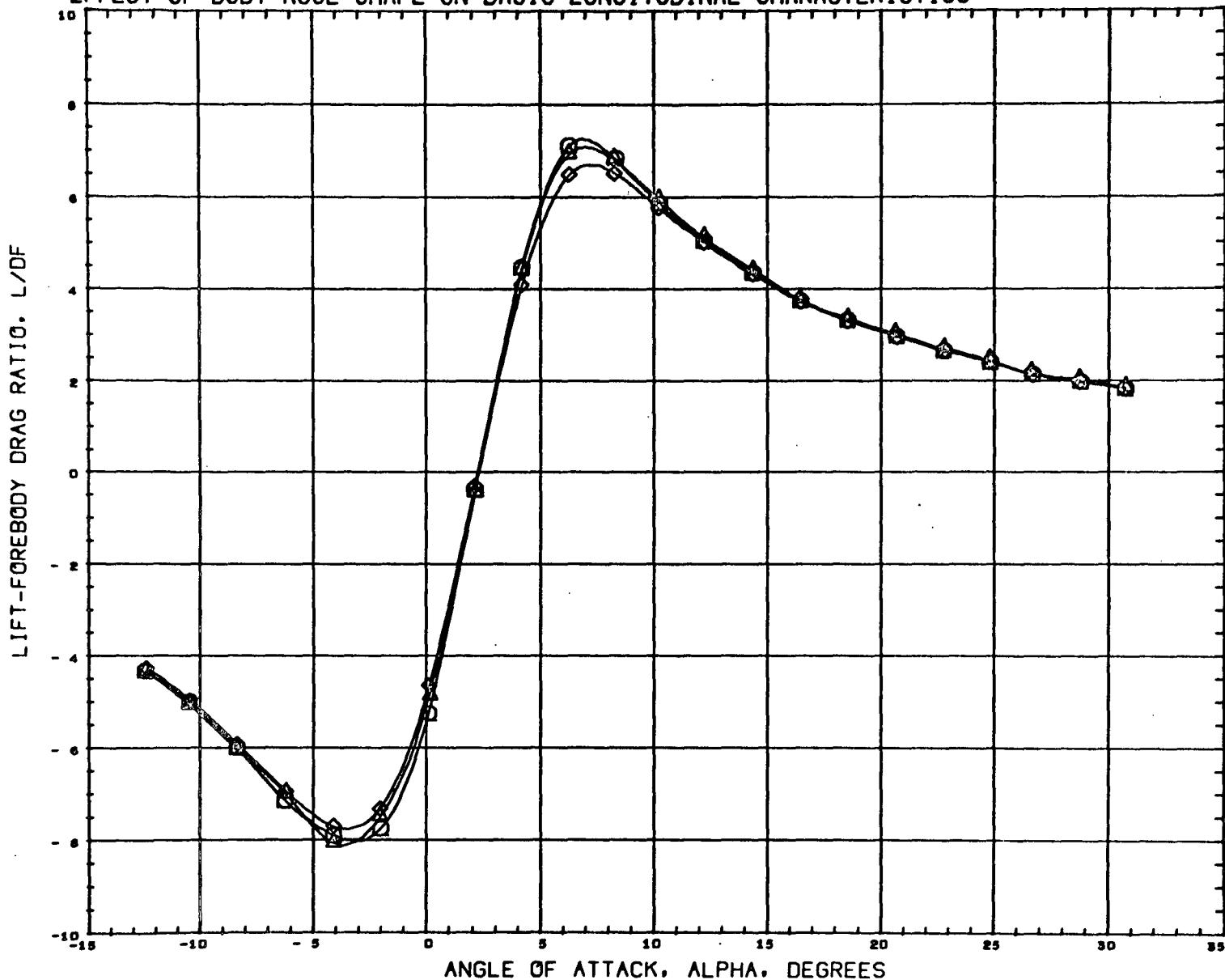
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## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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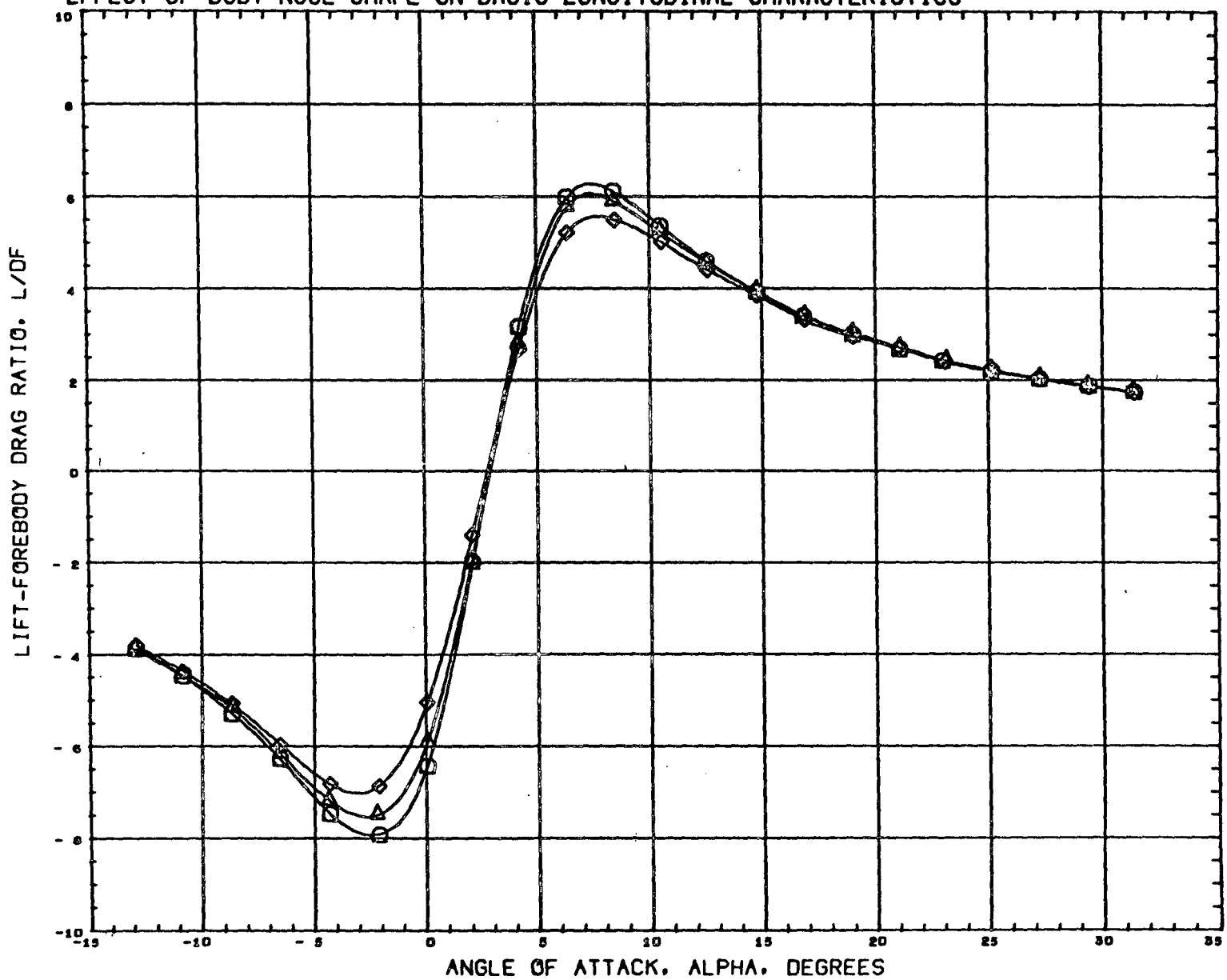
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MACH 0.605

PAGE 25

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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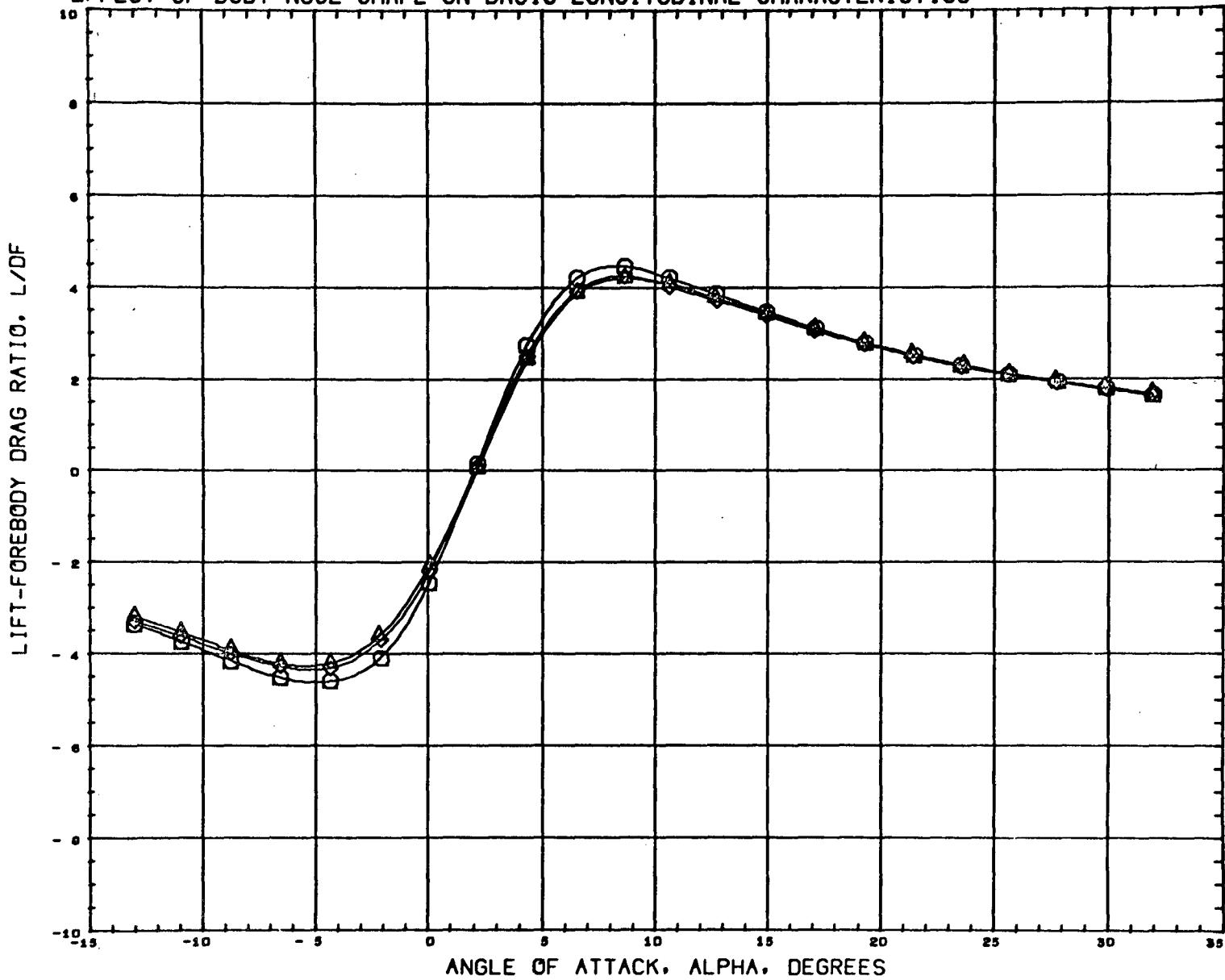
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MACH 0.898

PAGE 26

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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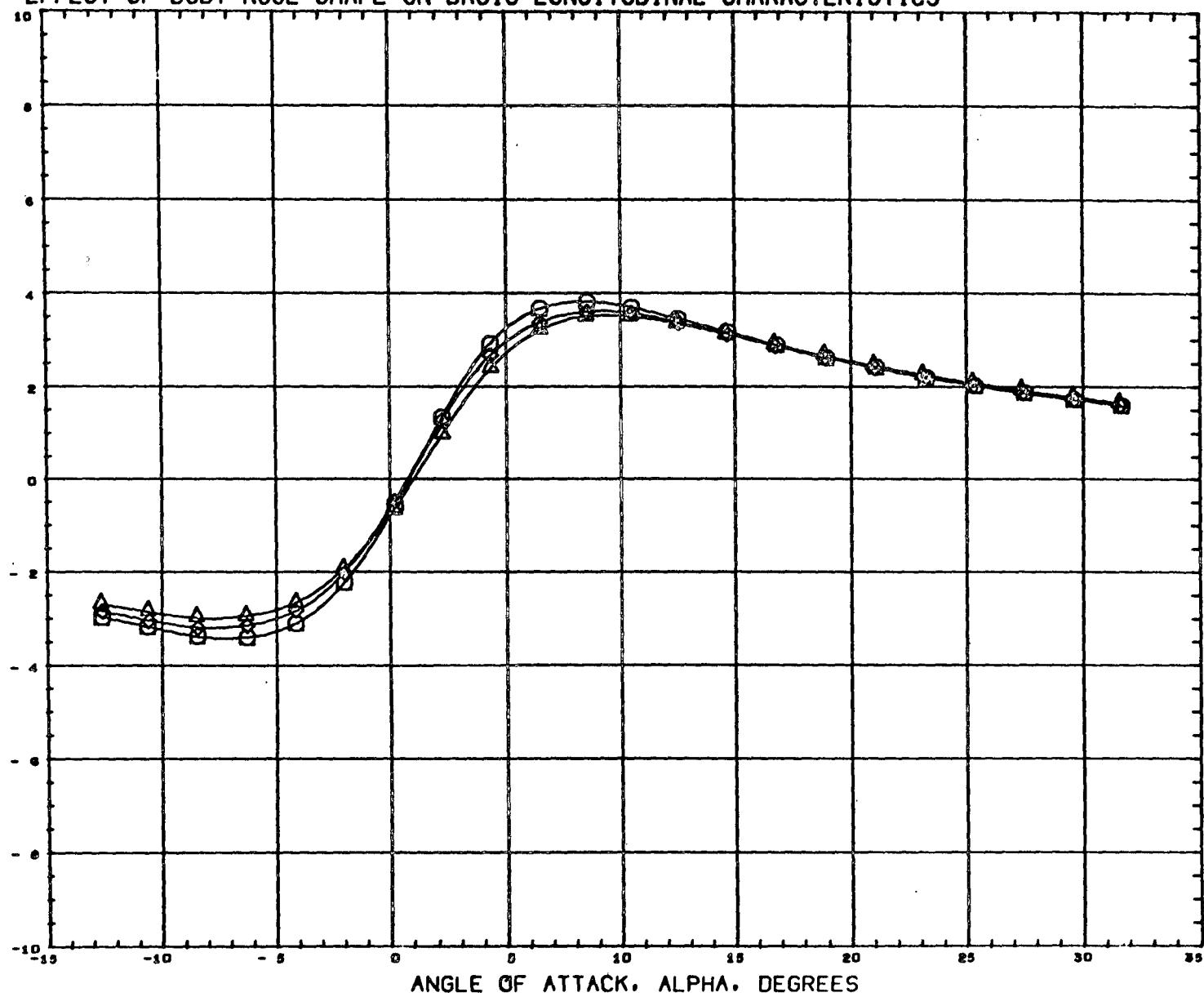
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MACH 1.194

PAGE 27

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO, L/D<sub>F</sub>



ANGLE OF ATTACK, ALPHA, DEGREES

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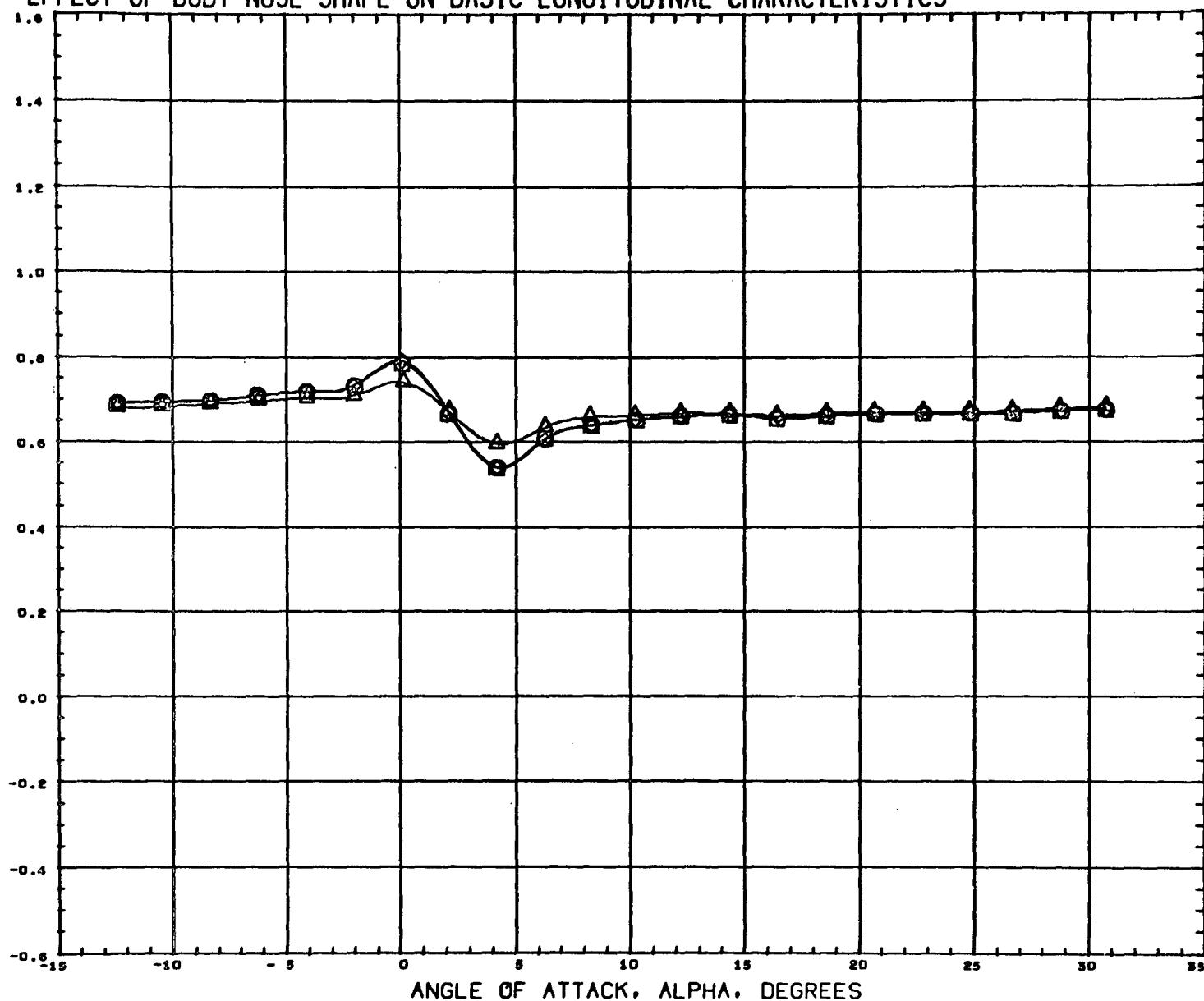
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MACH 1.961

PAGE 28

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE, XCP/L, PERCENT BODY LENGTH



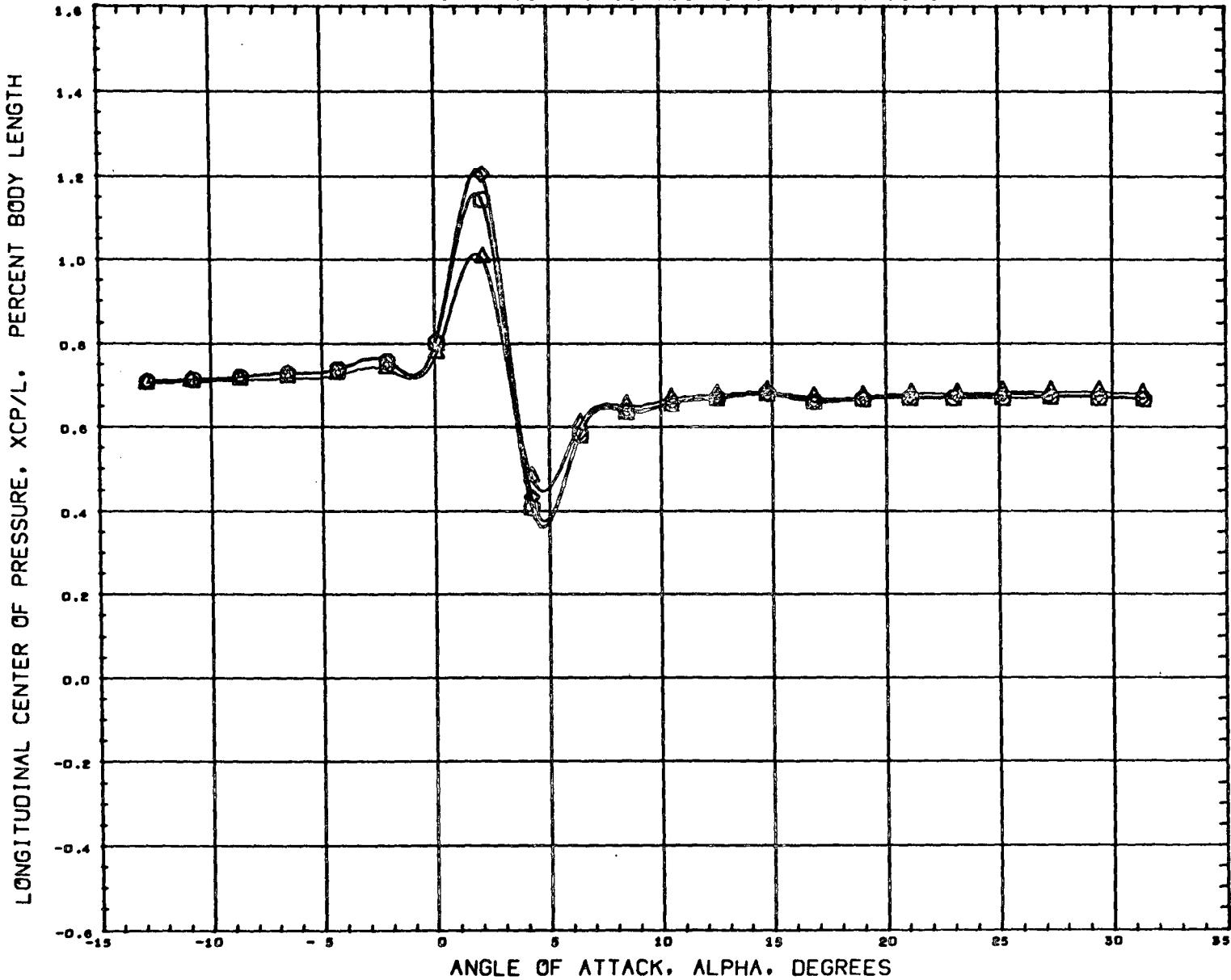
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MACH 0.605

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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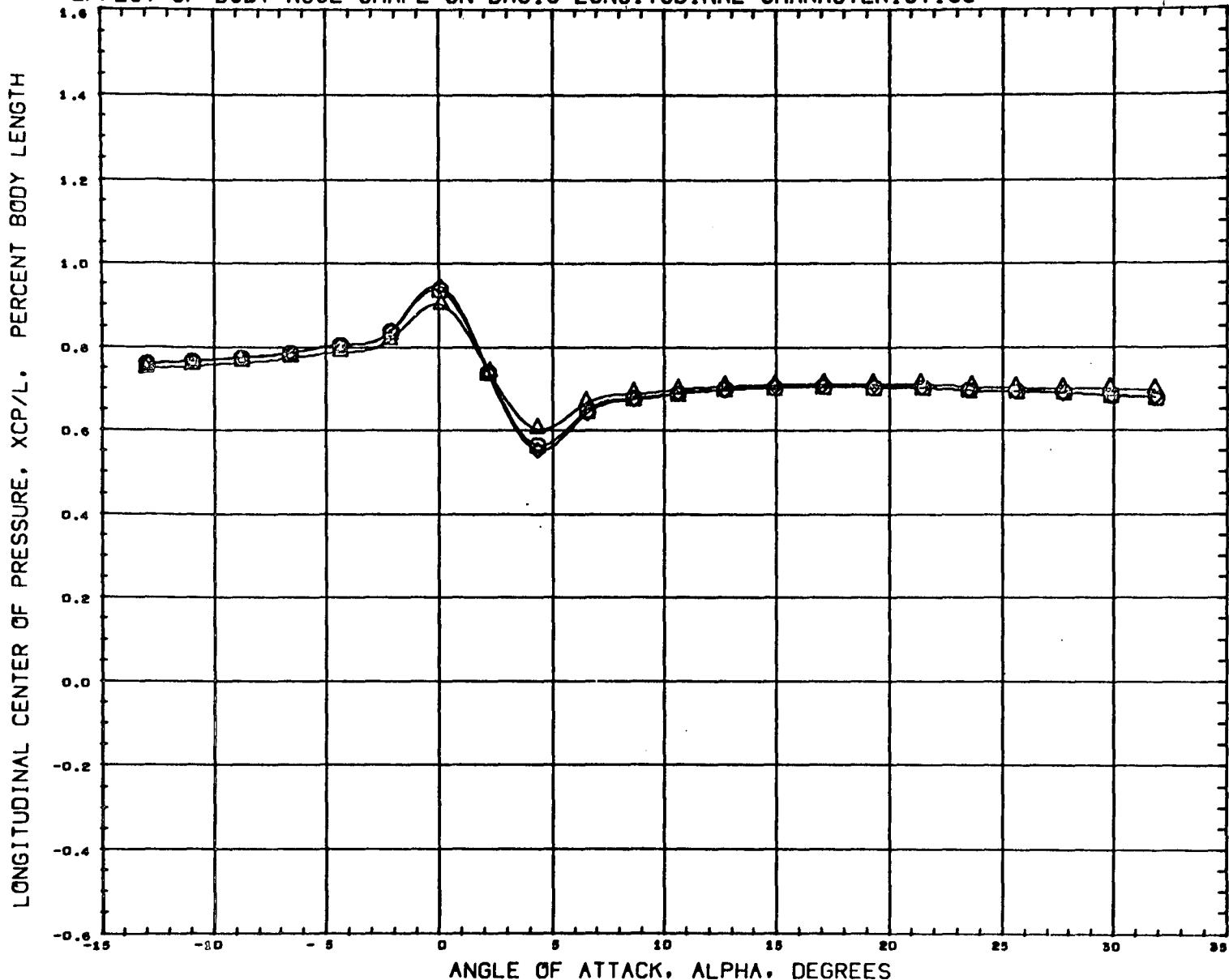
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MACH 0.898

PAGE 30

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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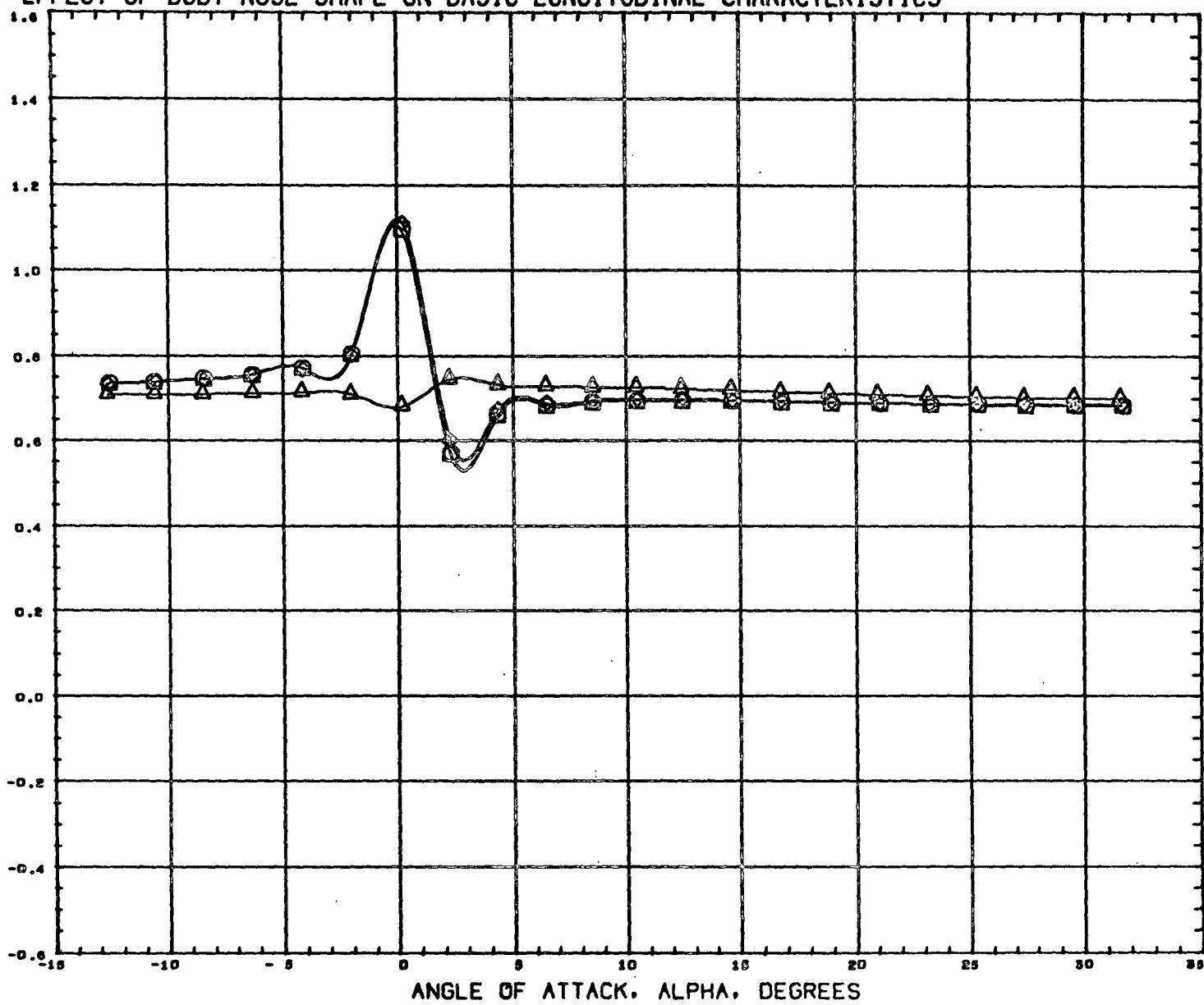
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MACH 1.194

PAGE 31

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE, XCP/L. PERCENT BODY LENGTH



DATA SET SYMBOL CONFIGURATION DESCRIPTION

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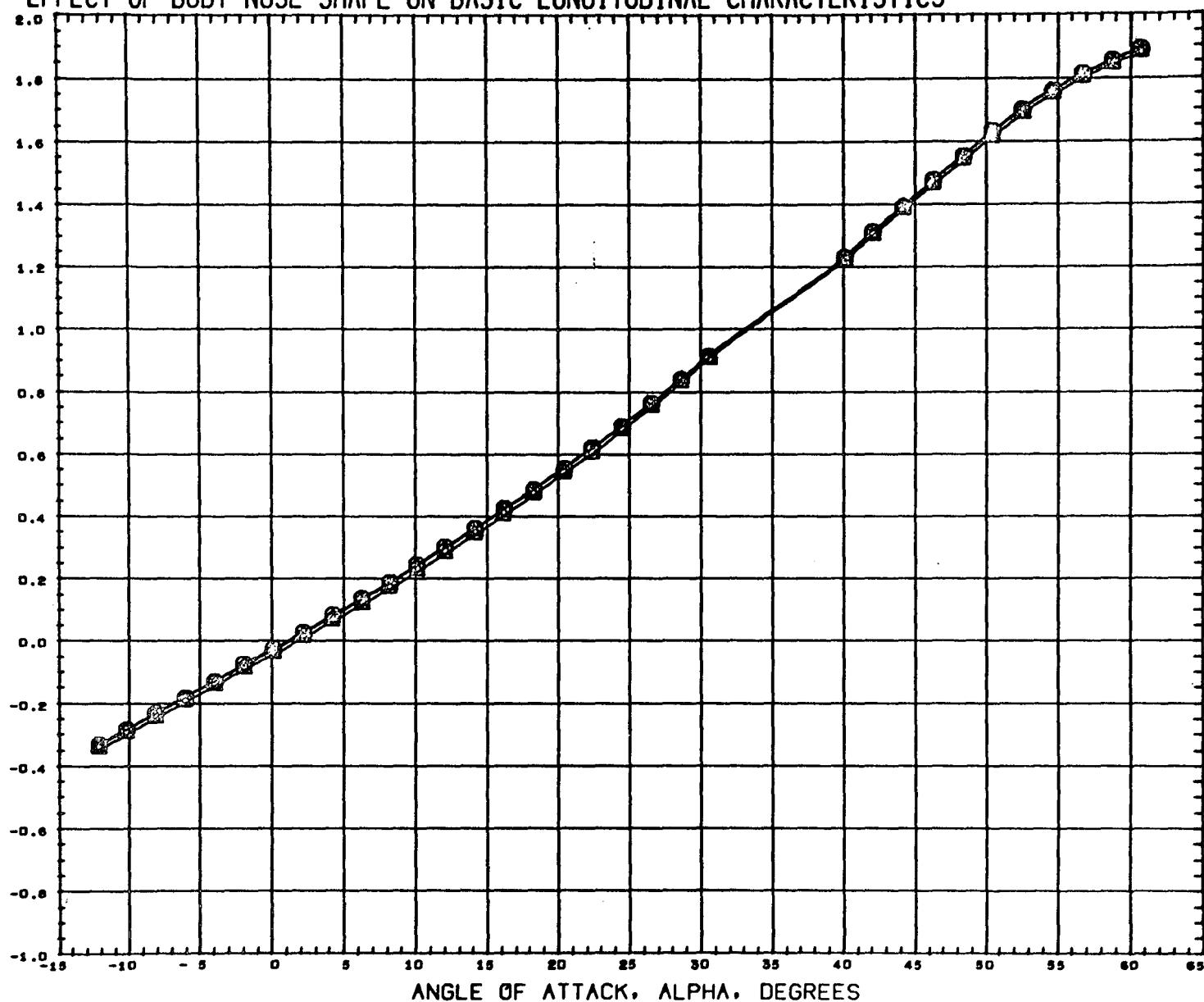
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MACH 1.961

PAGE 32

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

NORMAL FORCE COEFFICIENT, CN



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (D51018) MSFC509 NR 11OC ORBITER B12W26E16V36  
 (D51038) MSFC509 NR 11OC ORBITER B13W26E16V36  
 (D51048) MSFC509 NR 11OC ORBITER B14K3W26E16V36

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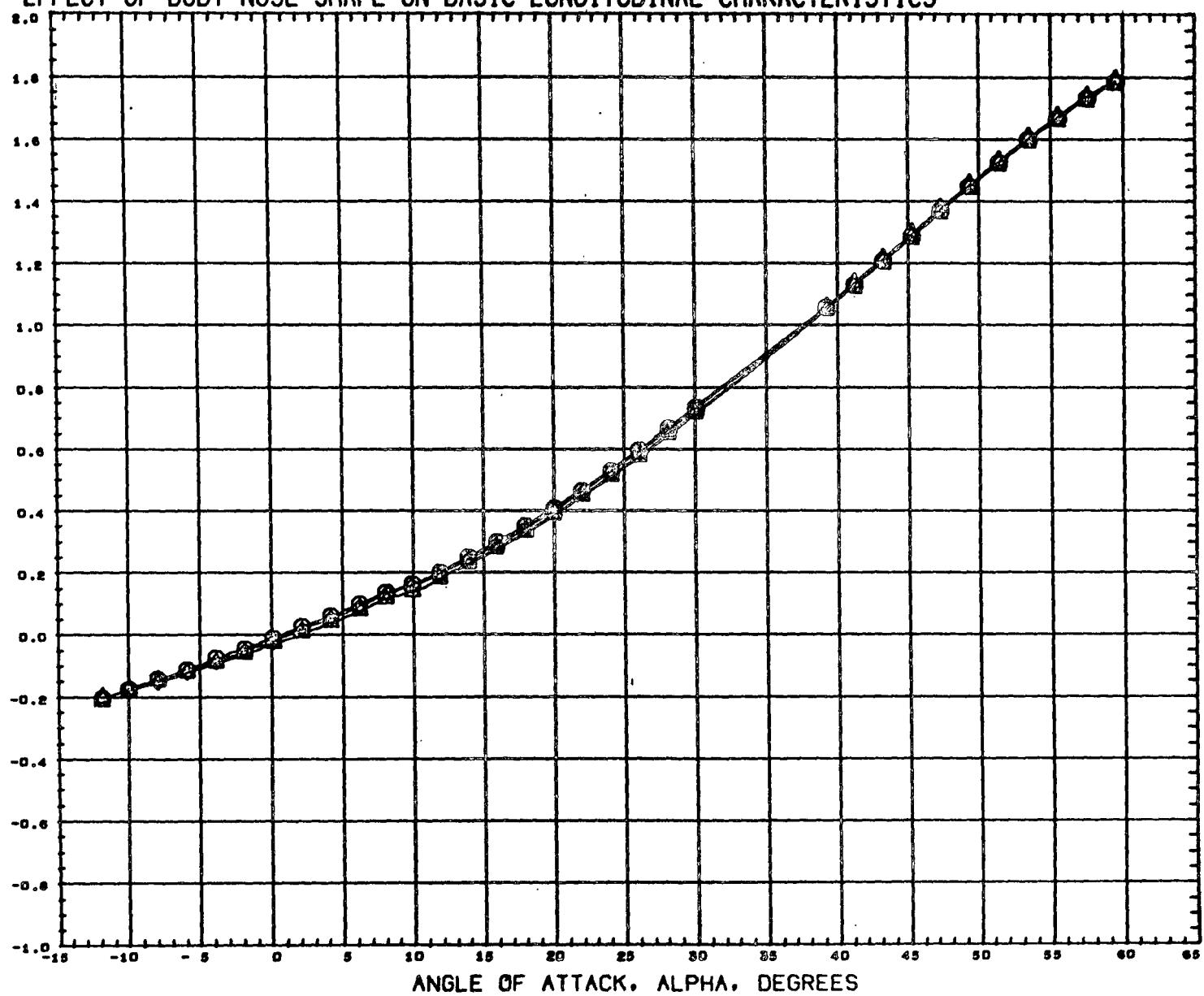
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 2.990

PAGE 33

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

NORMAL FORCE COEFFICIENT, CN



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (DS1018) Q MSFC509 NR 11OC ORBITER B12W26E16V36  
 (DS1038) S MSFC509 NR 11OC ORBITER B13W26E16V36  
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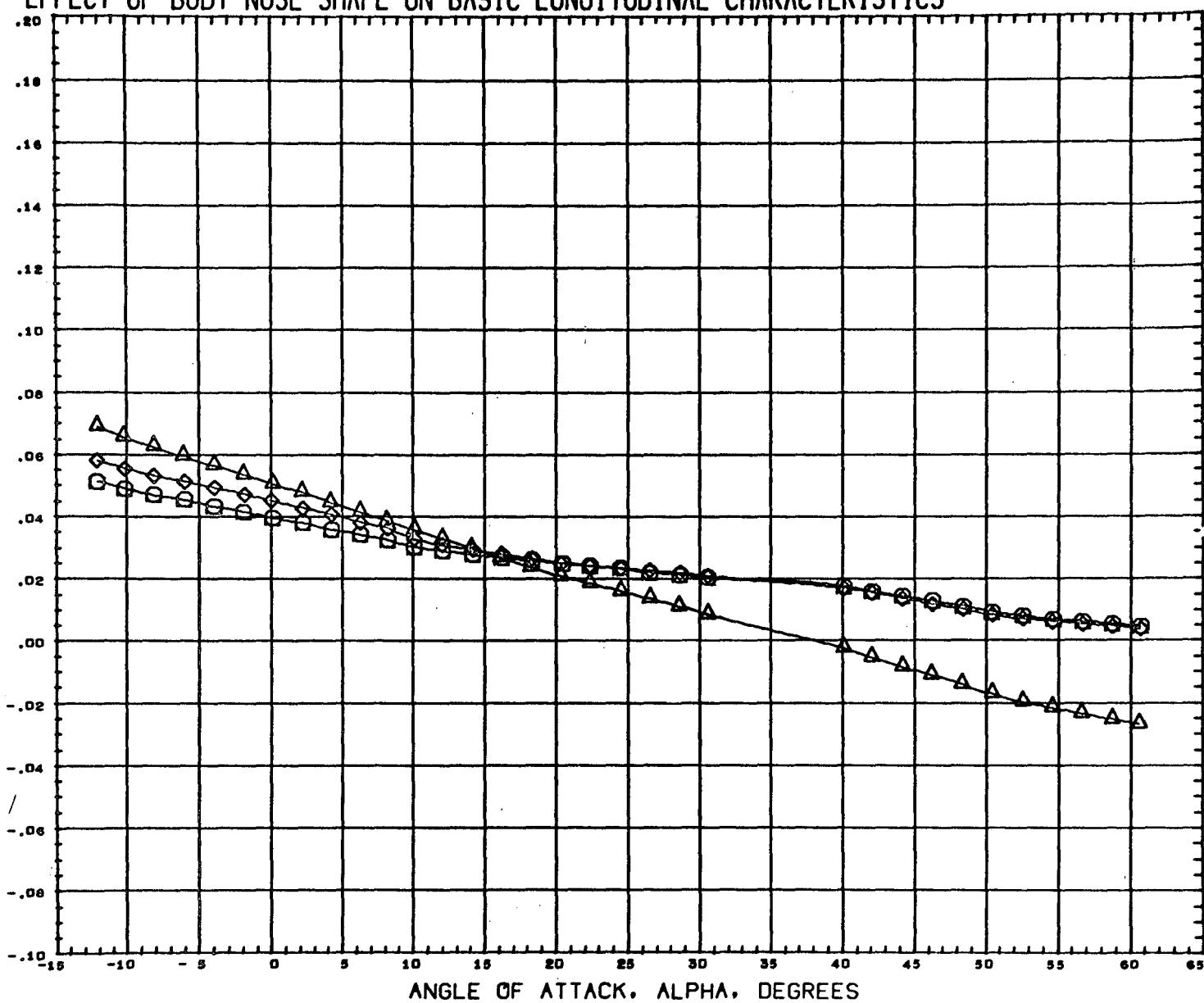
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 4.959

PAGE 34

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
(D51015) MSFC509 NR 110C ORBITER B12W26E16V36  
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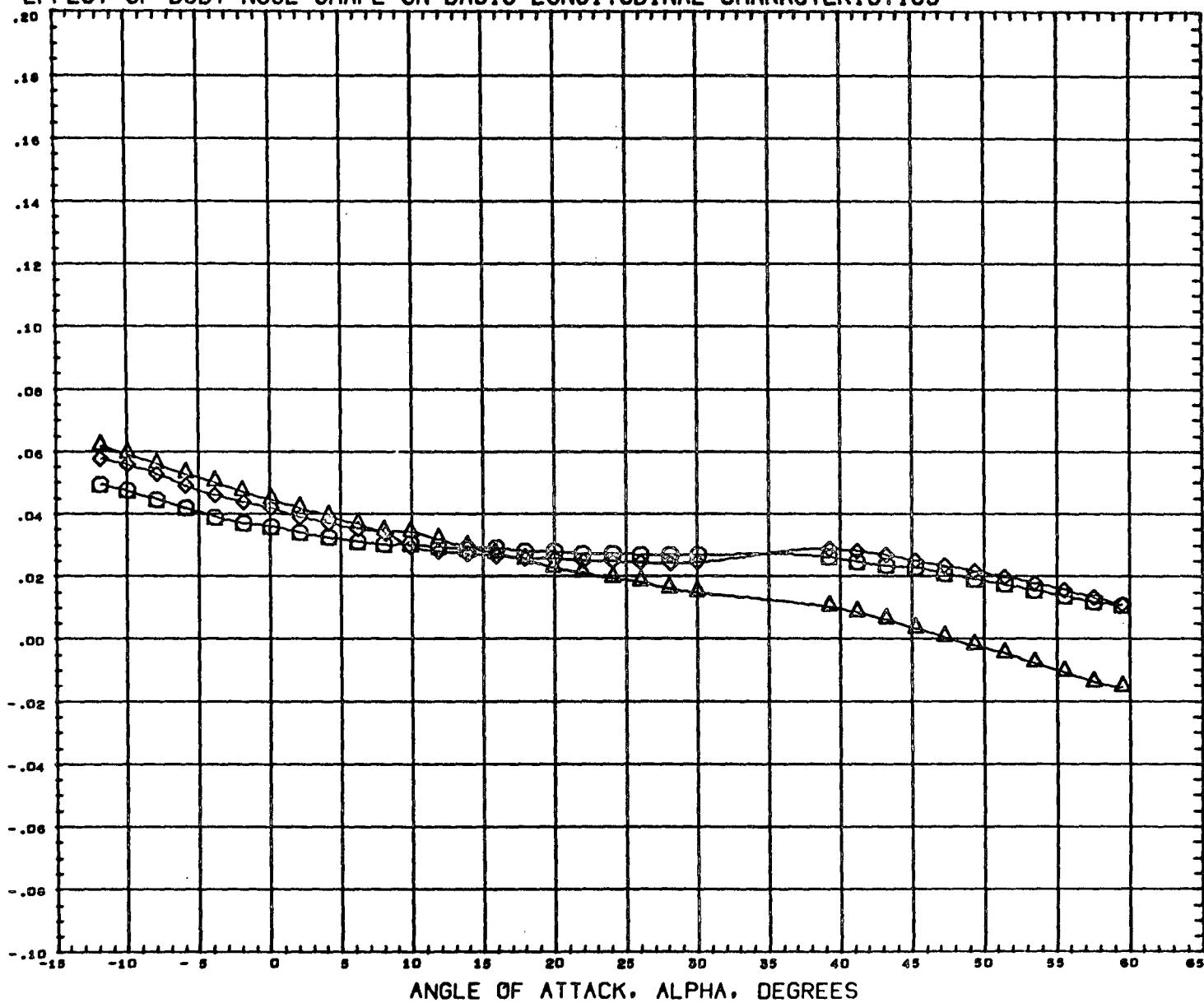
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SCALE 0.0044 SCALE

MACH 2.990

PAGE 35

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION

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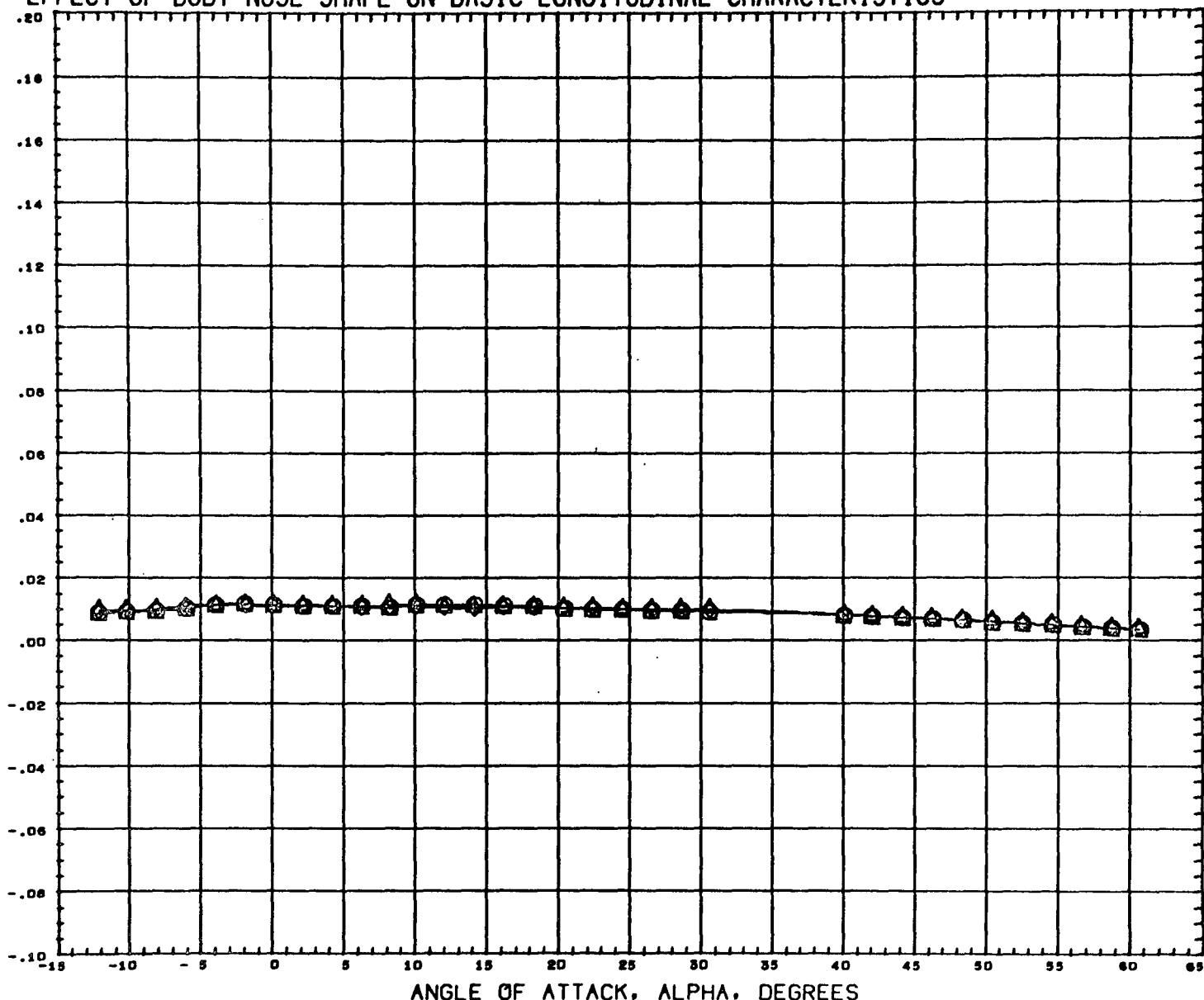
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SCALE	0.0044	SCALE

MACH 4.959

PAGE 36

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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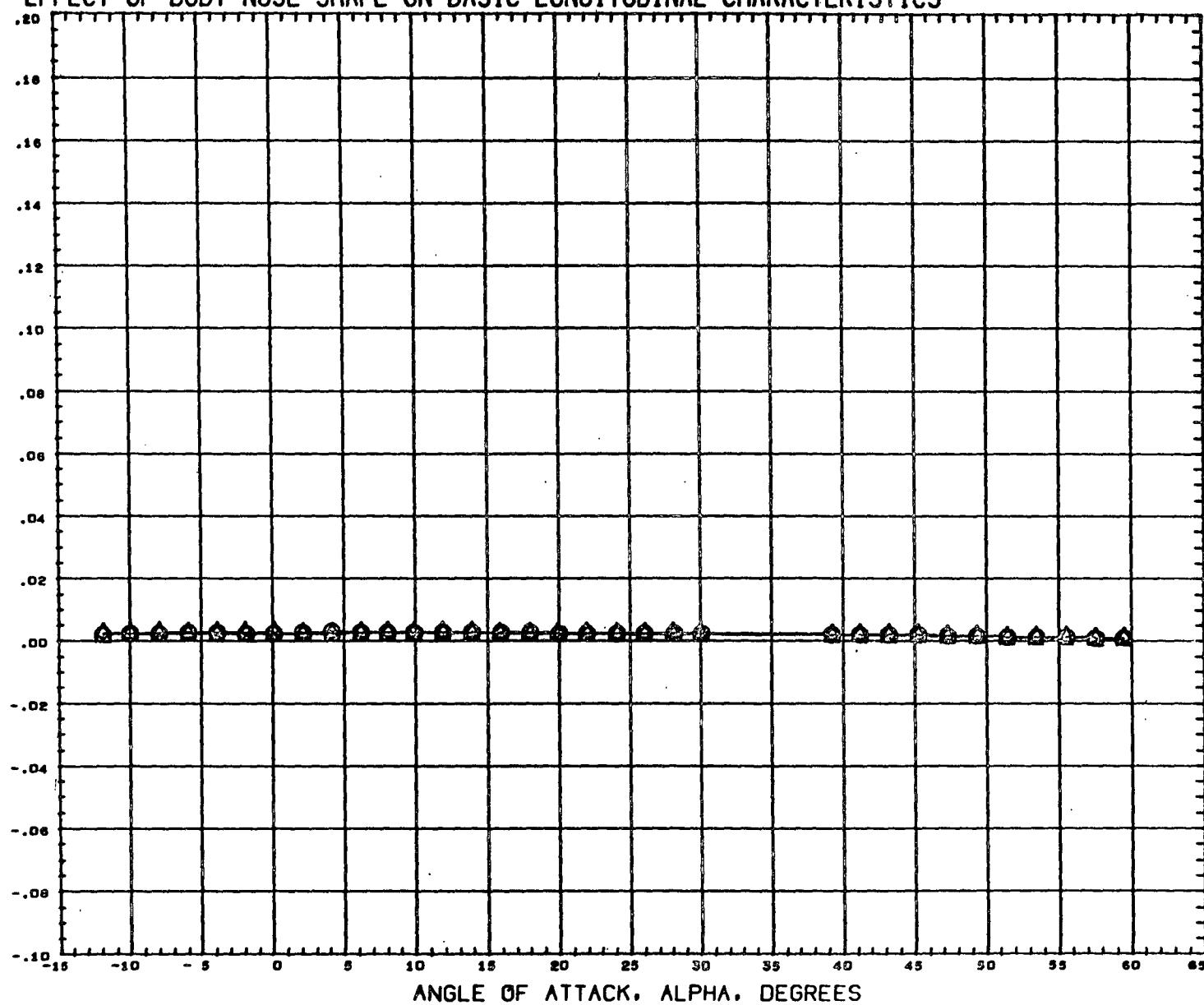
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 SCALE 0.0044 SCALE

MACH 2.990

PAGE 37

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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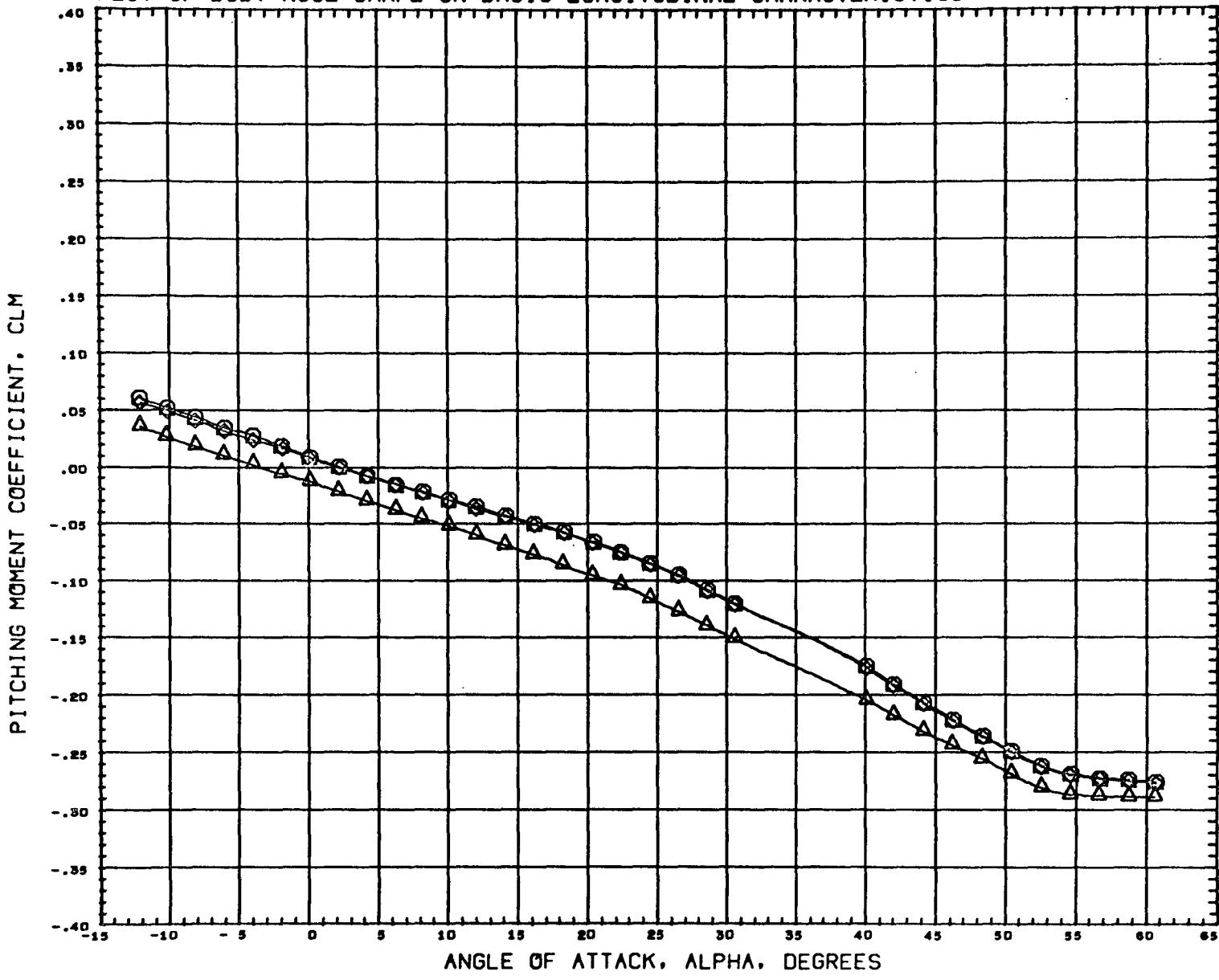
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MACH 4.959

PAGE 38

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



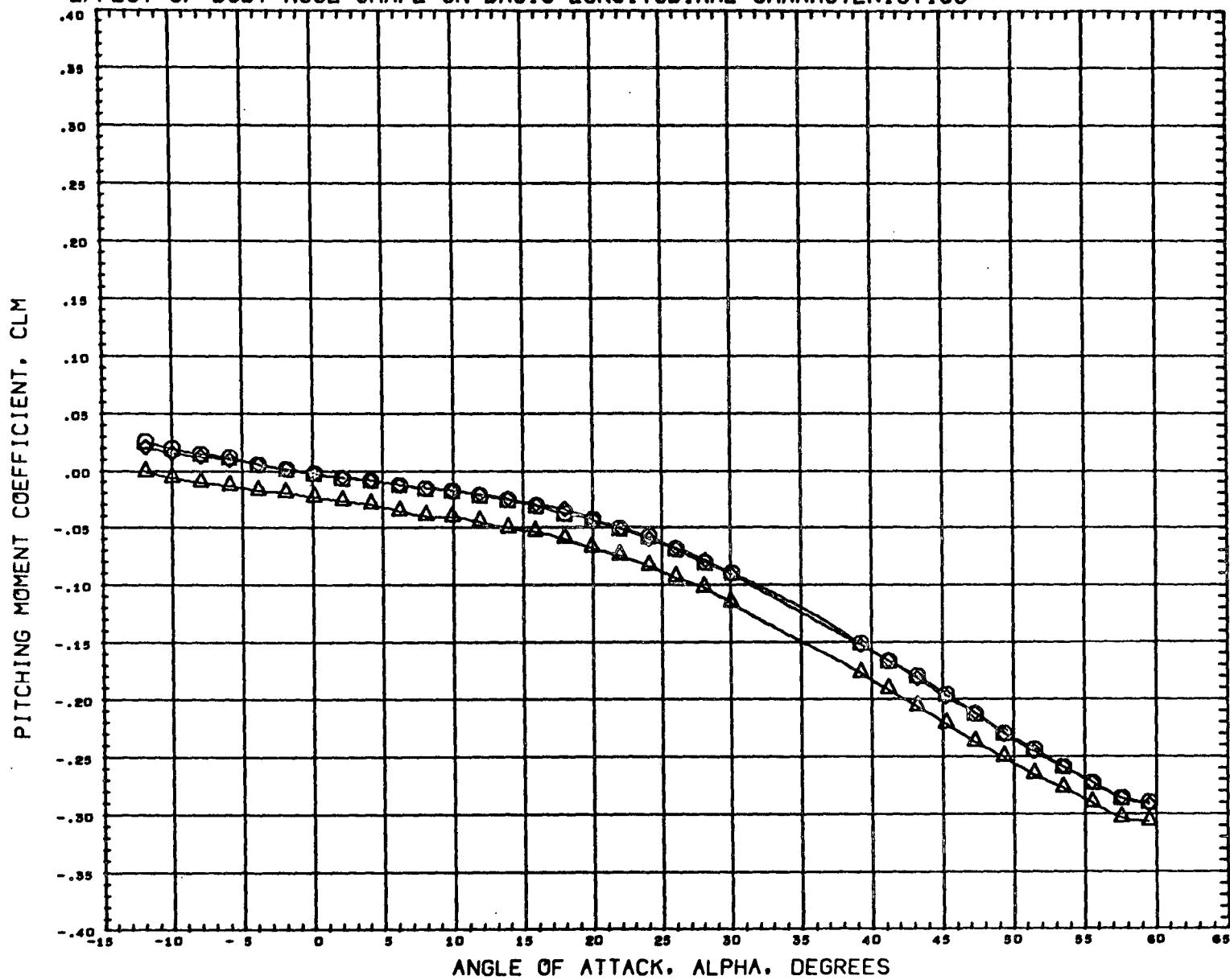
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MACH 2.990

## EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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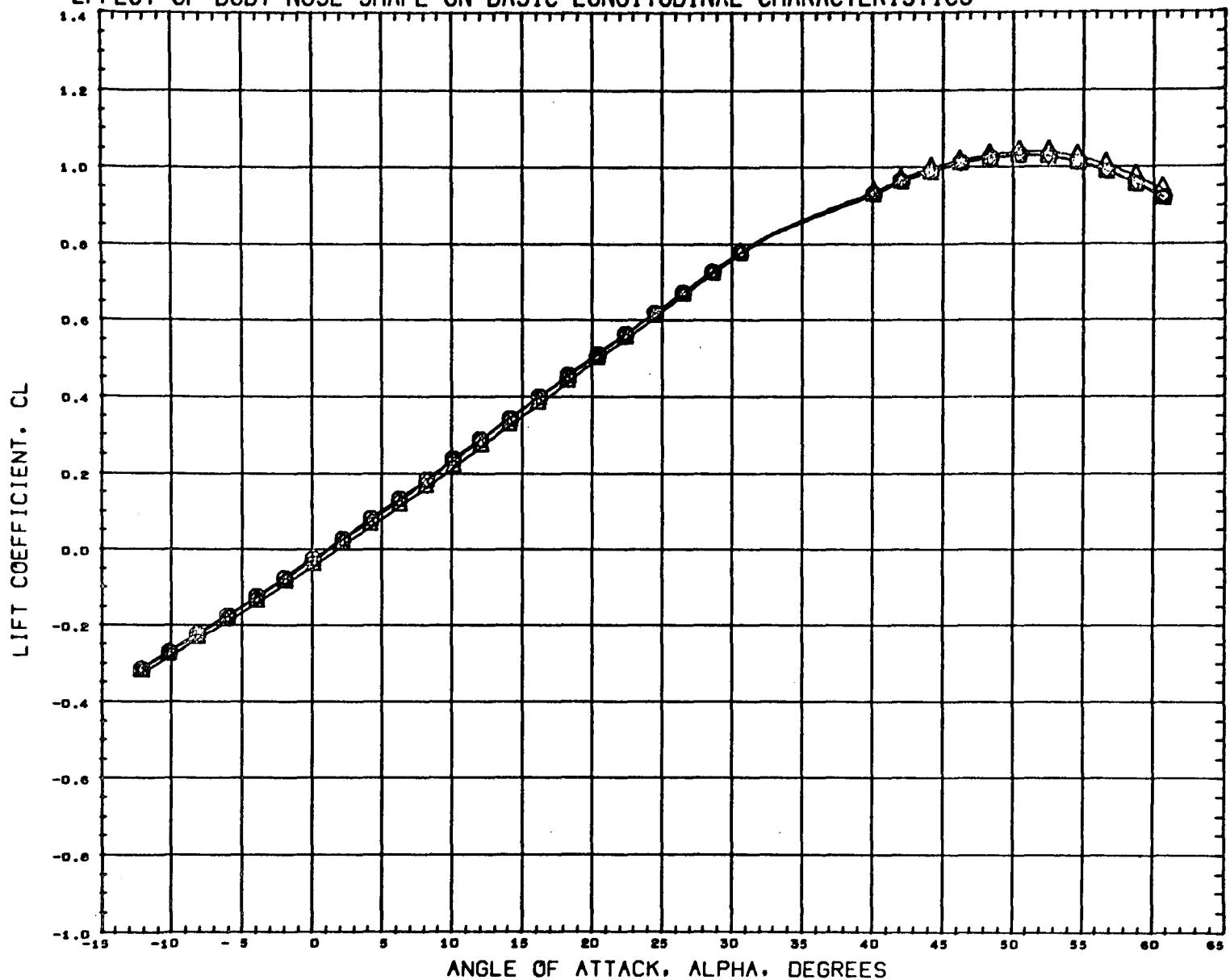
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MACH 4.050

PAGE 40

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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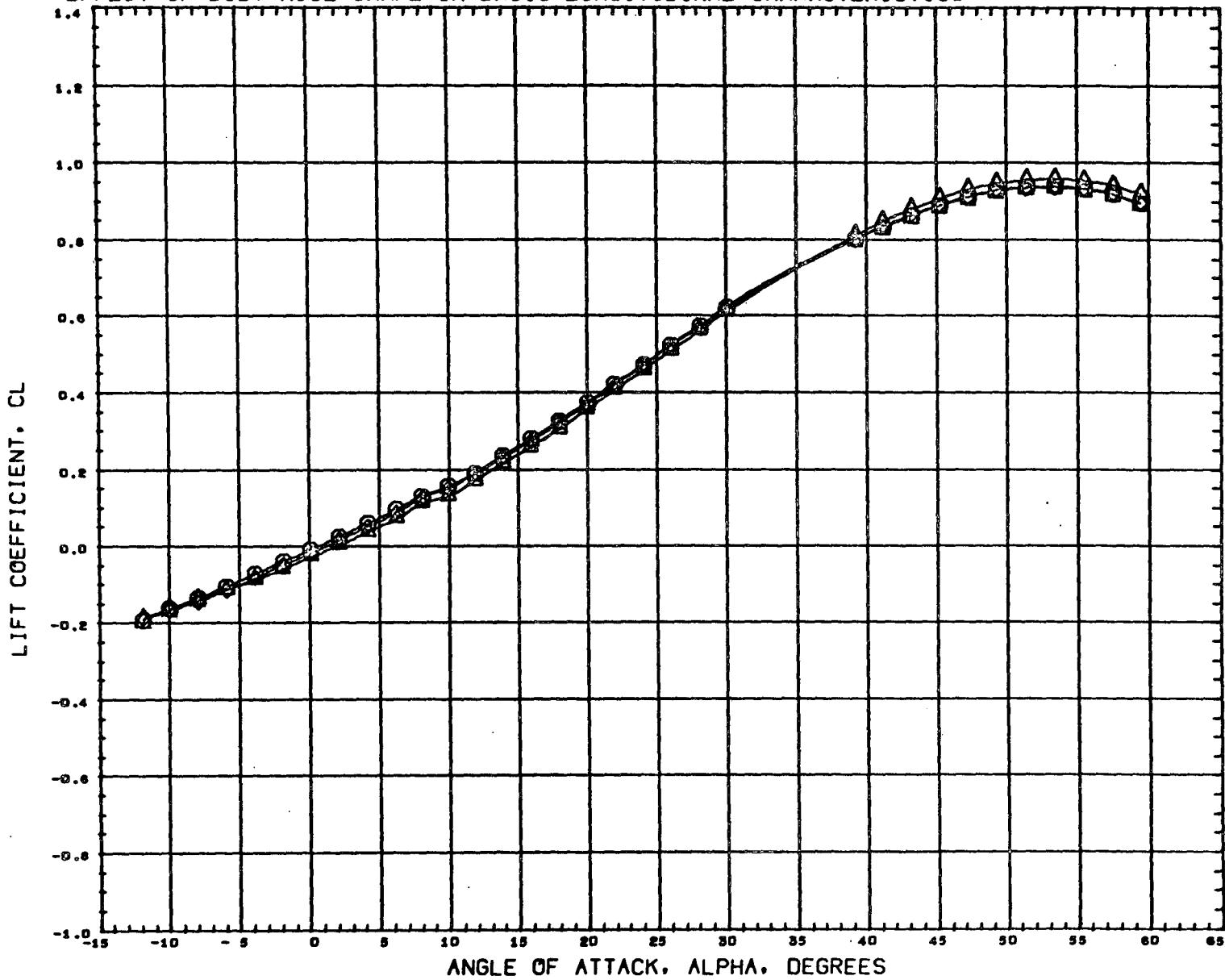
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 SCALE 0.0044 SCALE

MACH 2.990

PAGE 41

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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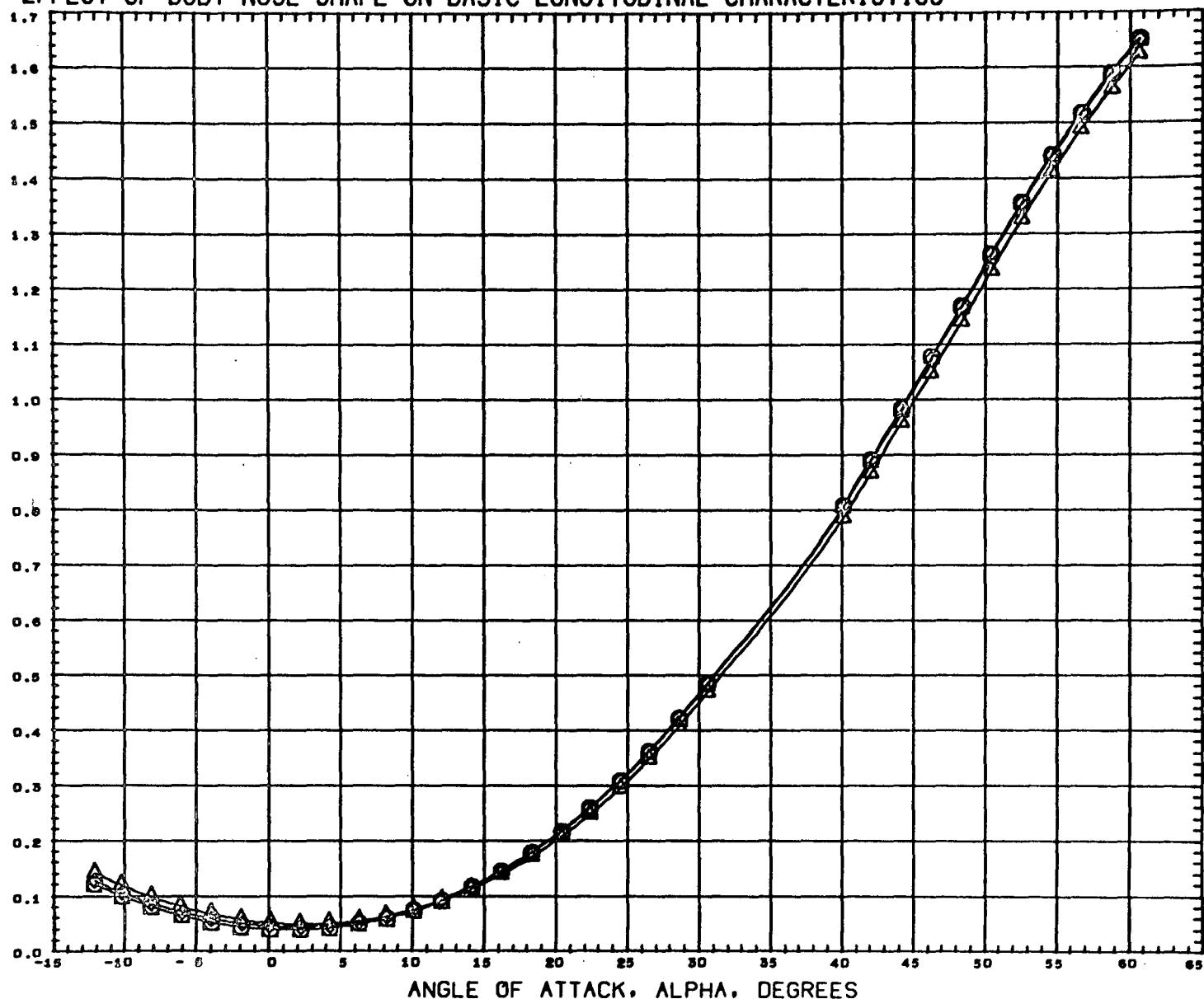
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 SCALE 0.0044 SCALE

MACH 4.059

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, CDF



DATA SET SYMBOL CONFIGURATION DESCRIPTION

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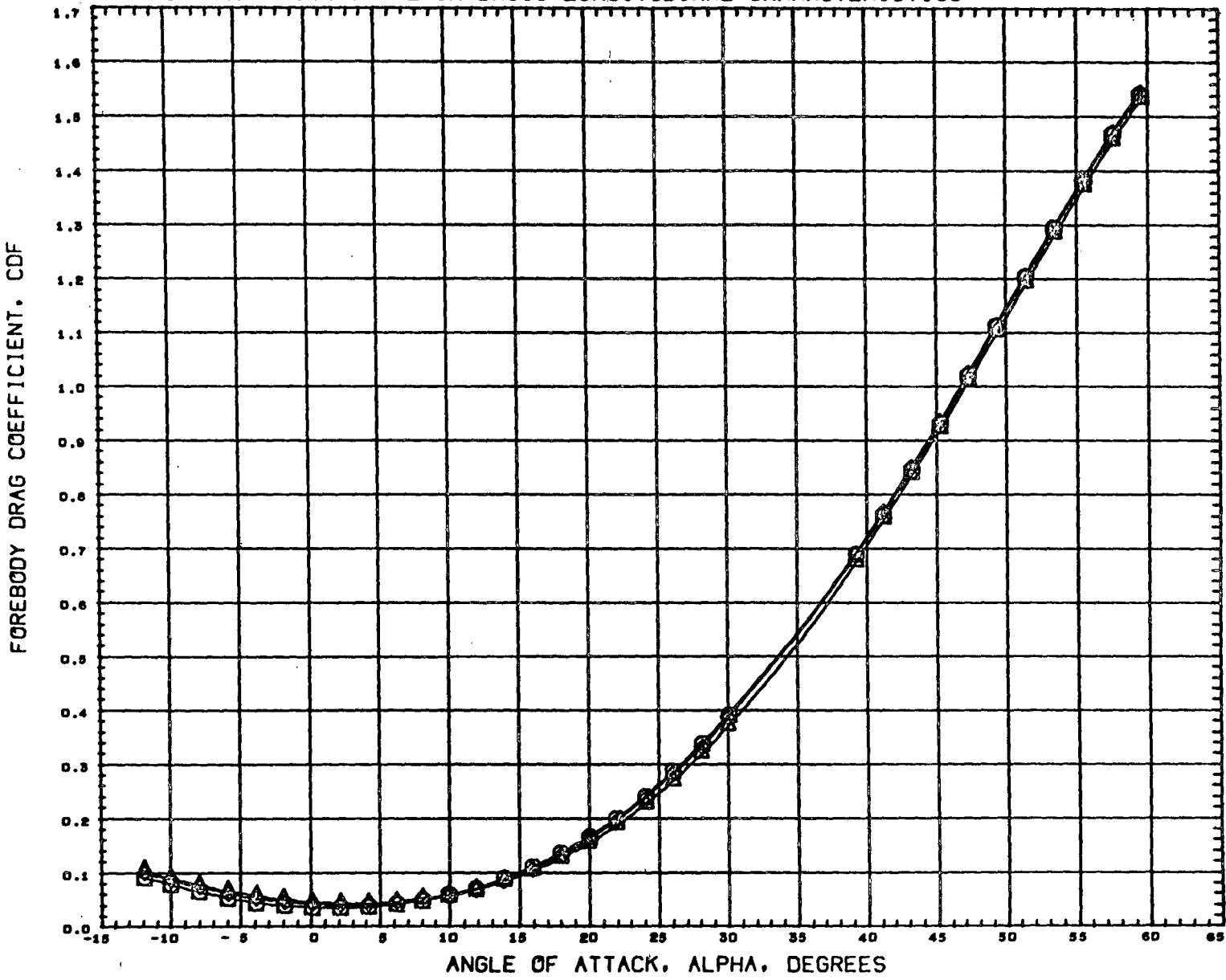
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MACH 2.090

PAGE 43

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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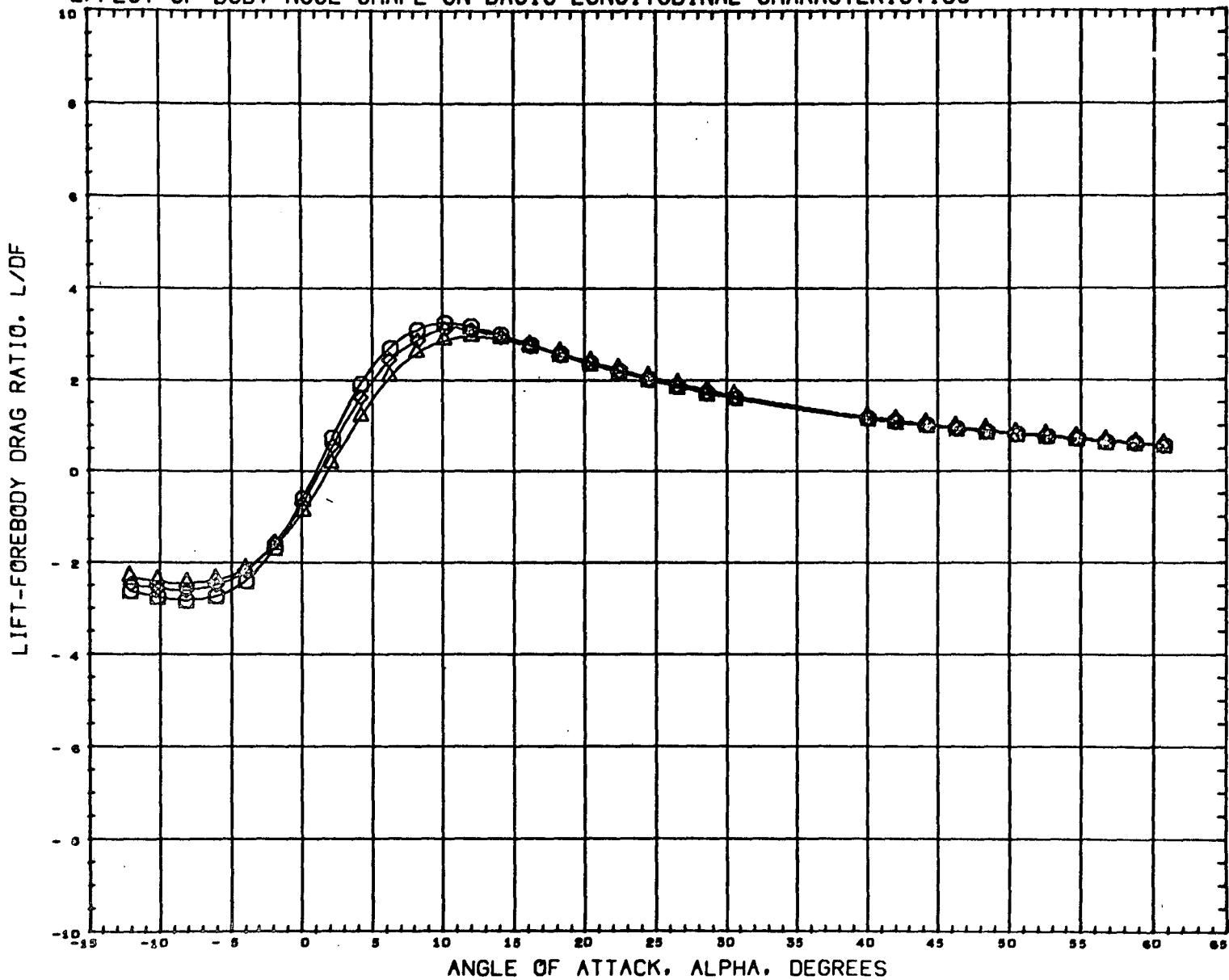
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MACH 4.959

PAGE 44

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



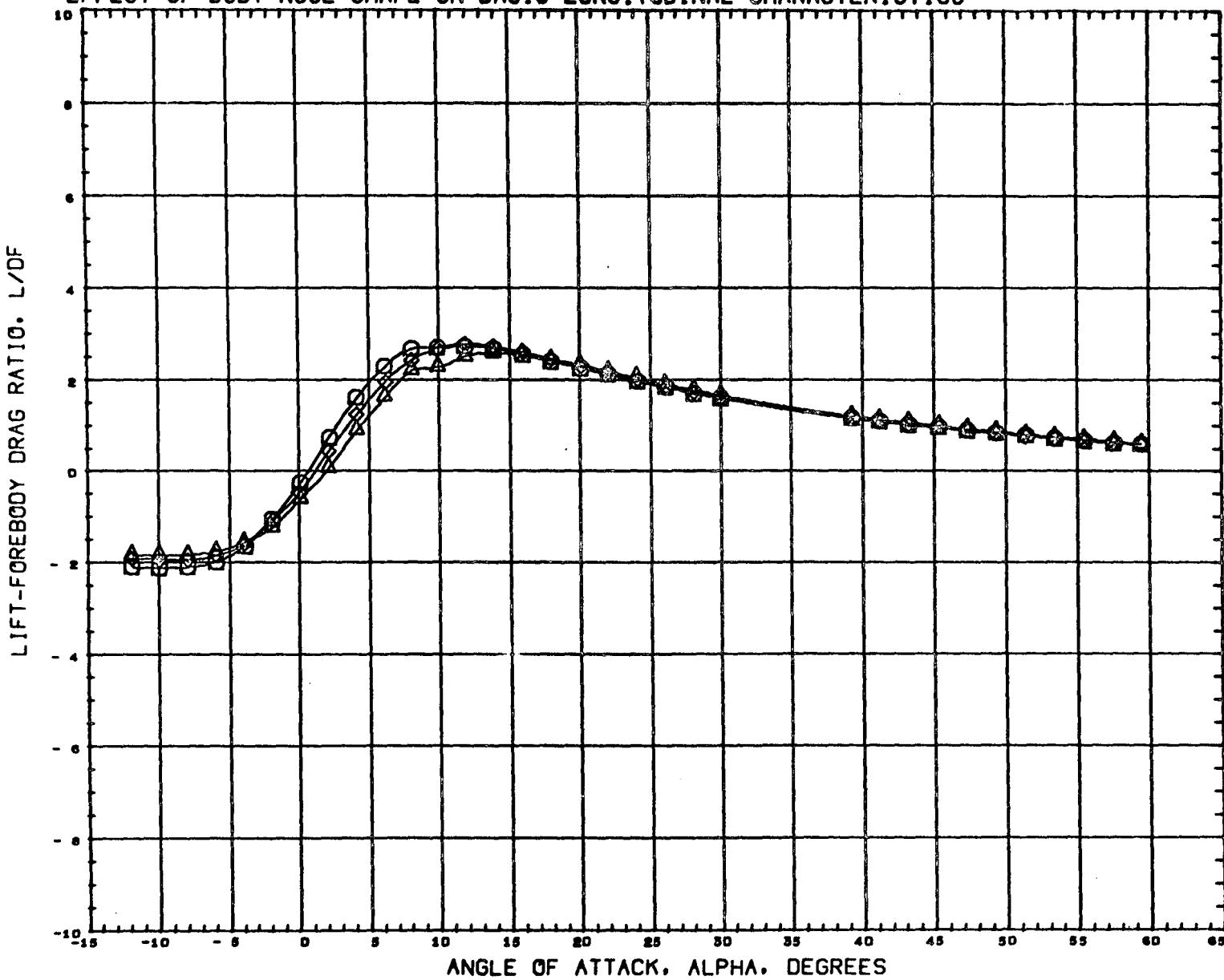
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MACH 2.990

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS

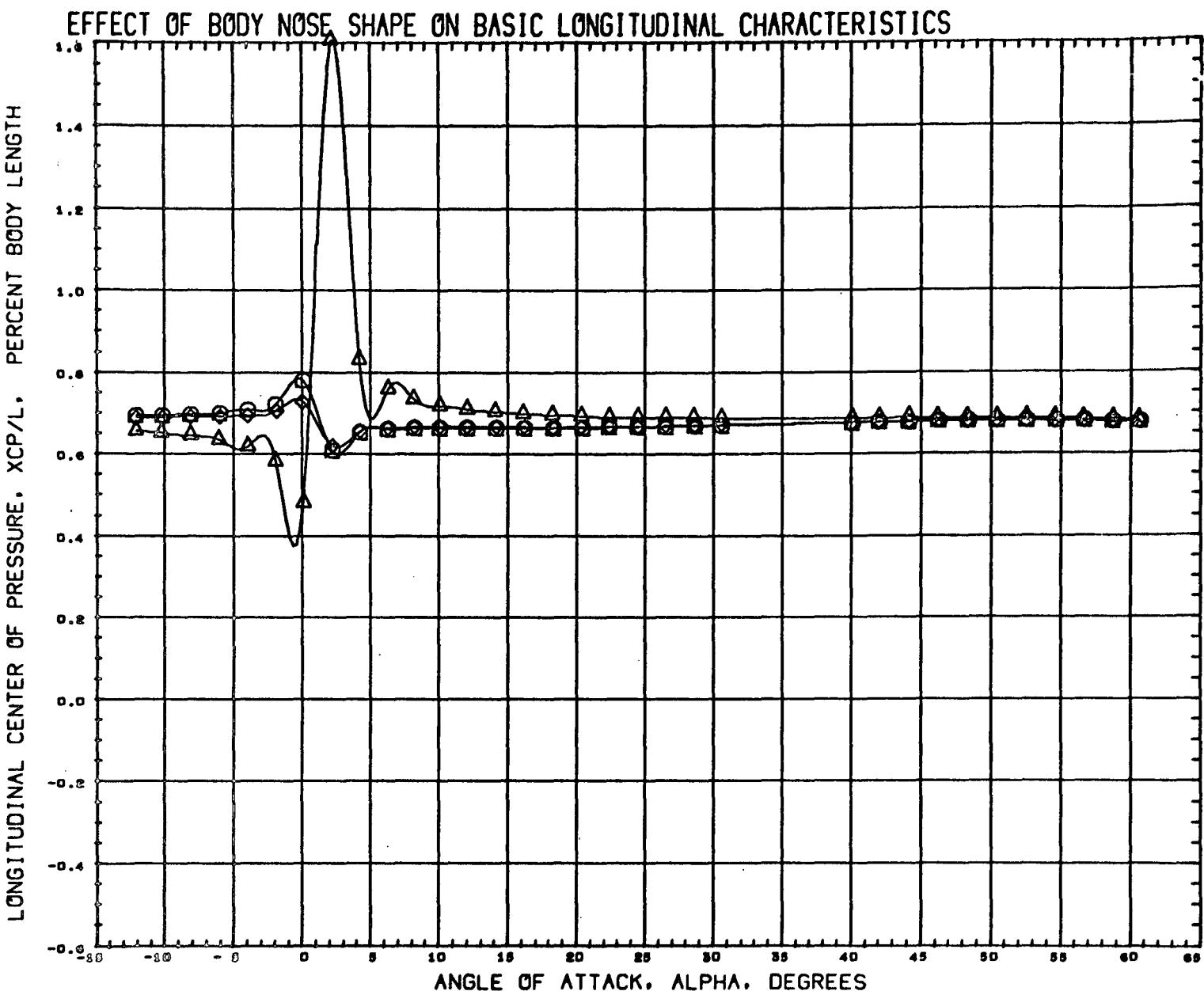


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MACH 4.259



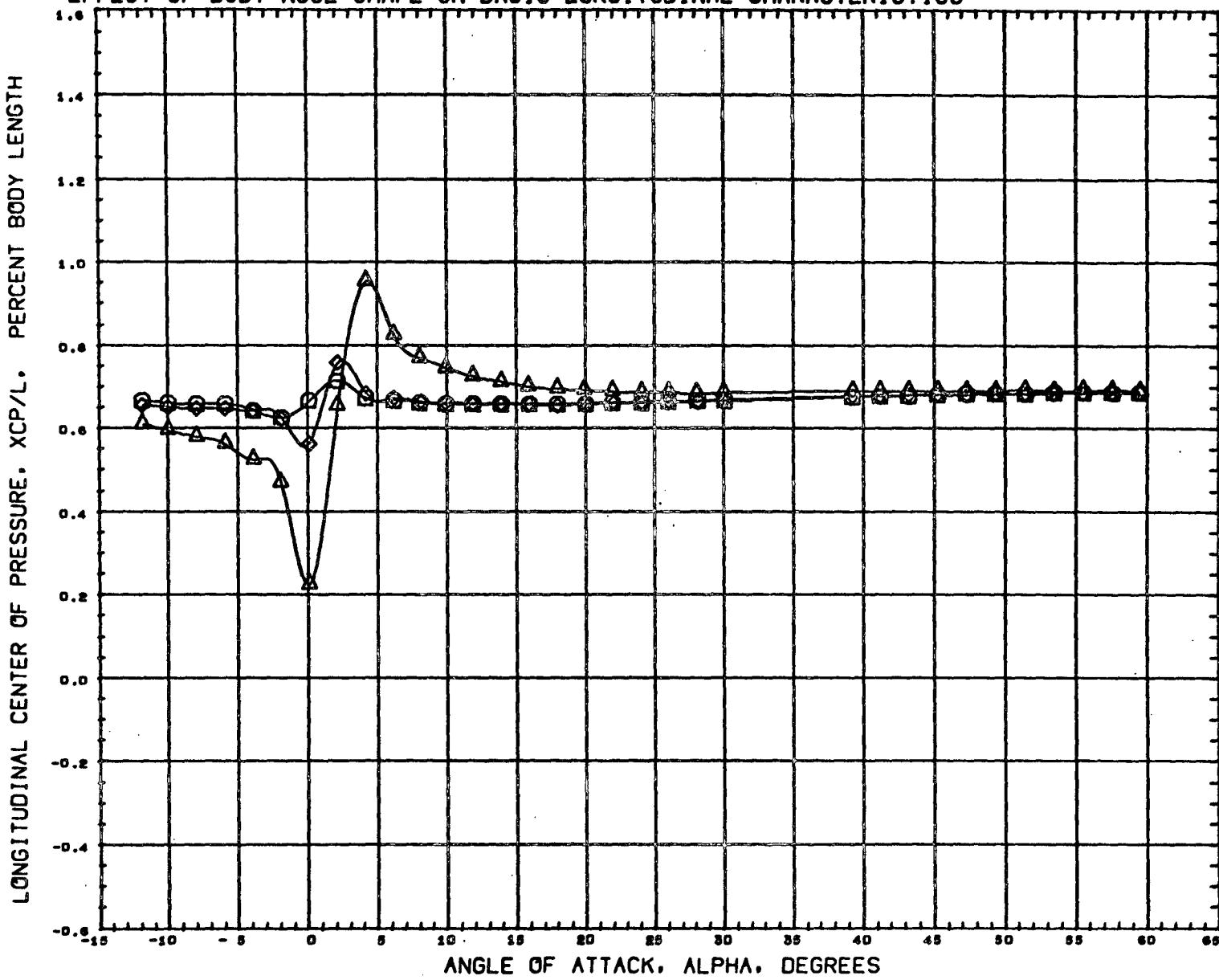
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MACH 2.990

# EFFECT OF BODY NOSE SHAPE ON BASIC LONGITUDINAL CHARACTERISTICS



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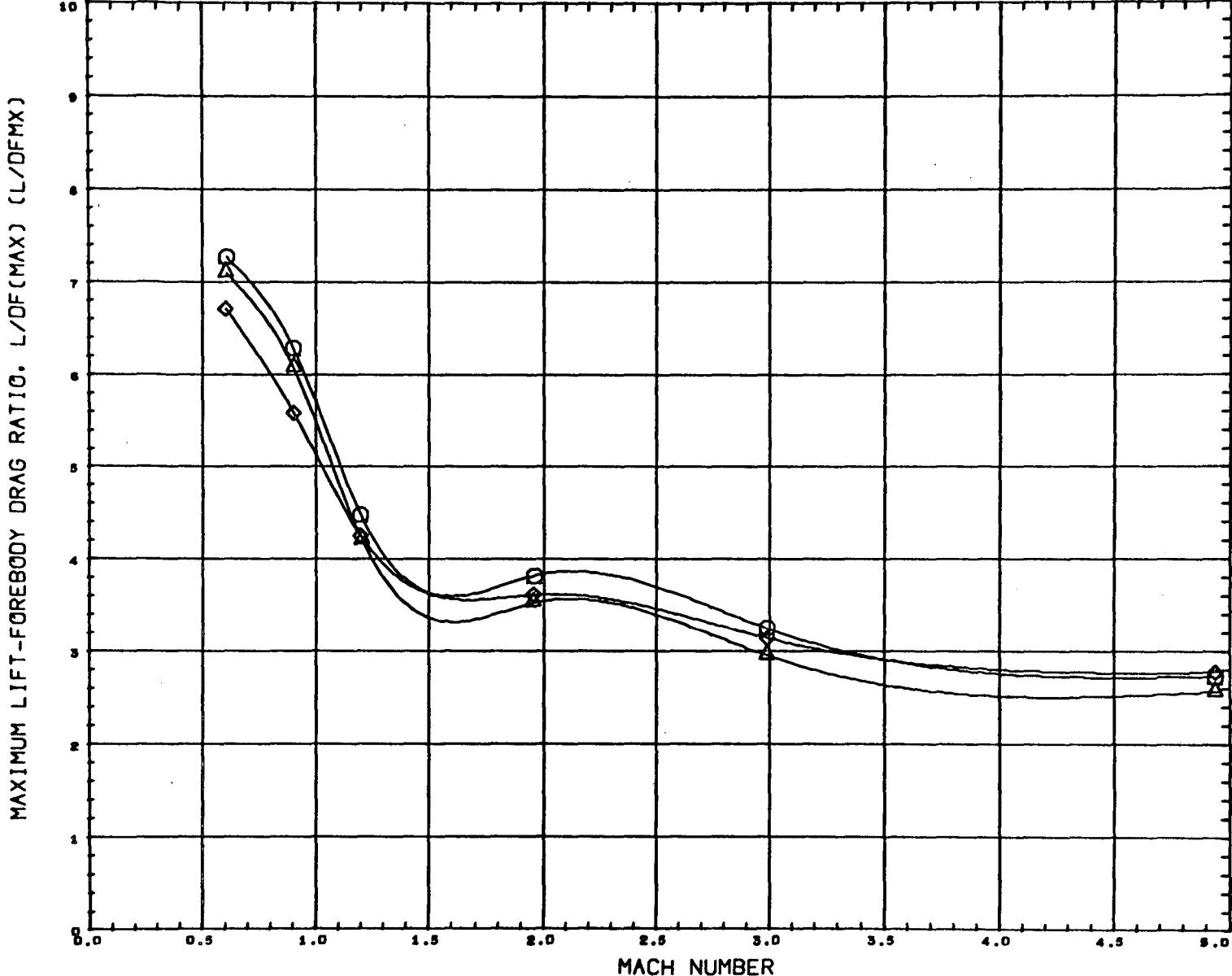
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MACH 4.859

PAGE 48

# EFFECT OF BODY NOSE SHAPE ON DESIGN FUNCTIONS AT MAXIMUM L/D.

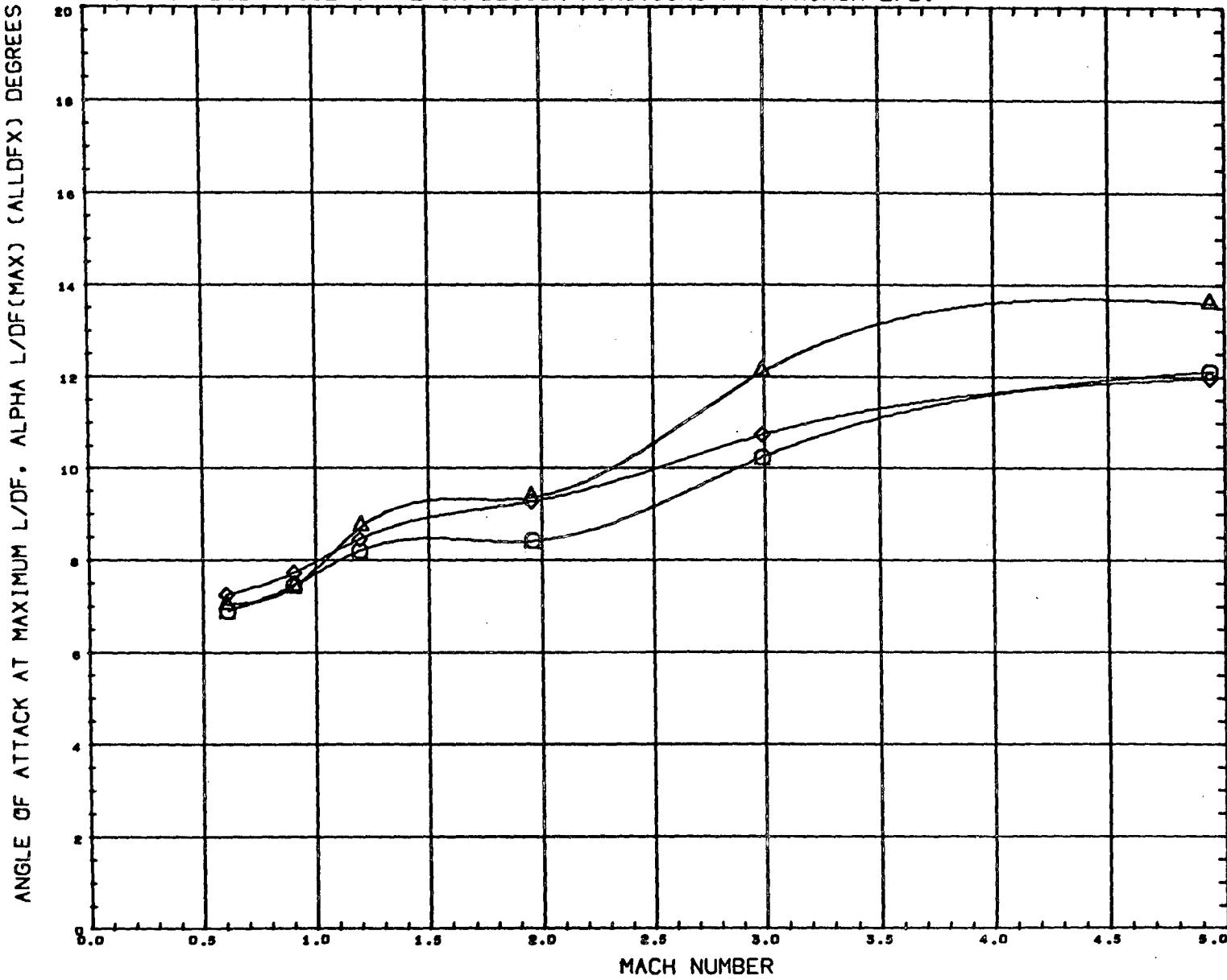


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EFFECT OF BODY NOSE SHAPE ON DESIGN FUNCTIONS AT MAXIMUM L/D.



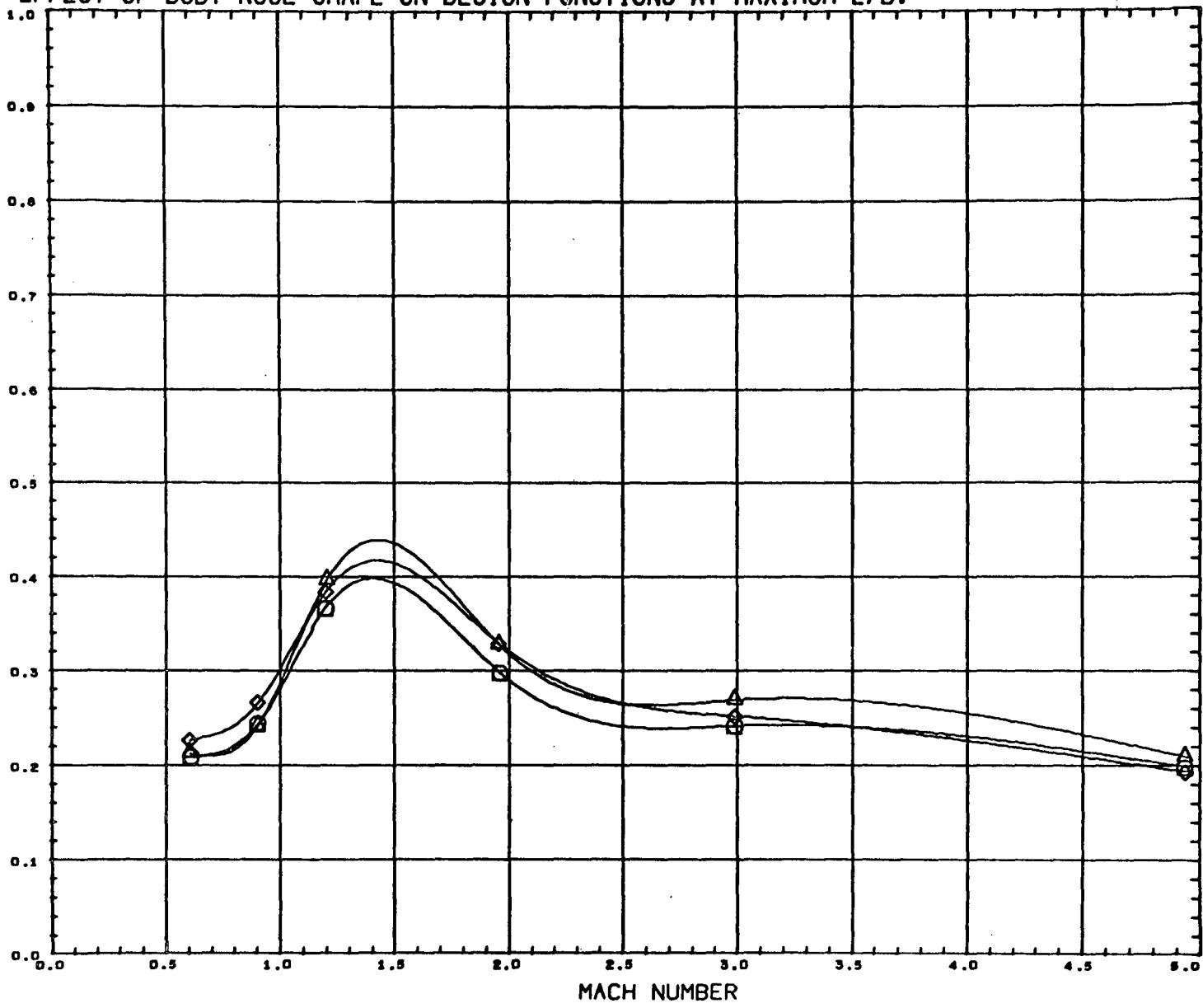
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EFFECT OF BODY NOSE SHAPE ON DESIGN FUNCTIONS AT MAXIMUM L/D.

LIFT COEFFICIENT AT MAXIMUM L/DF. CL L/DF(MAX) (CLLDFX)



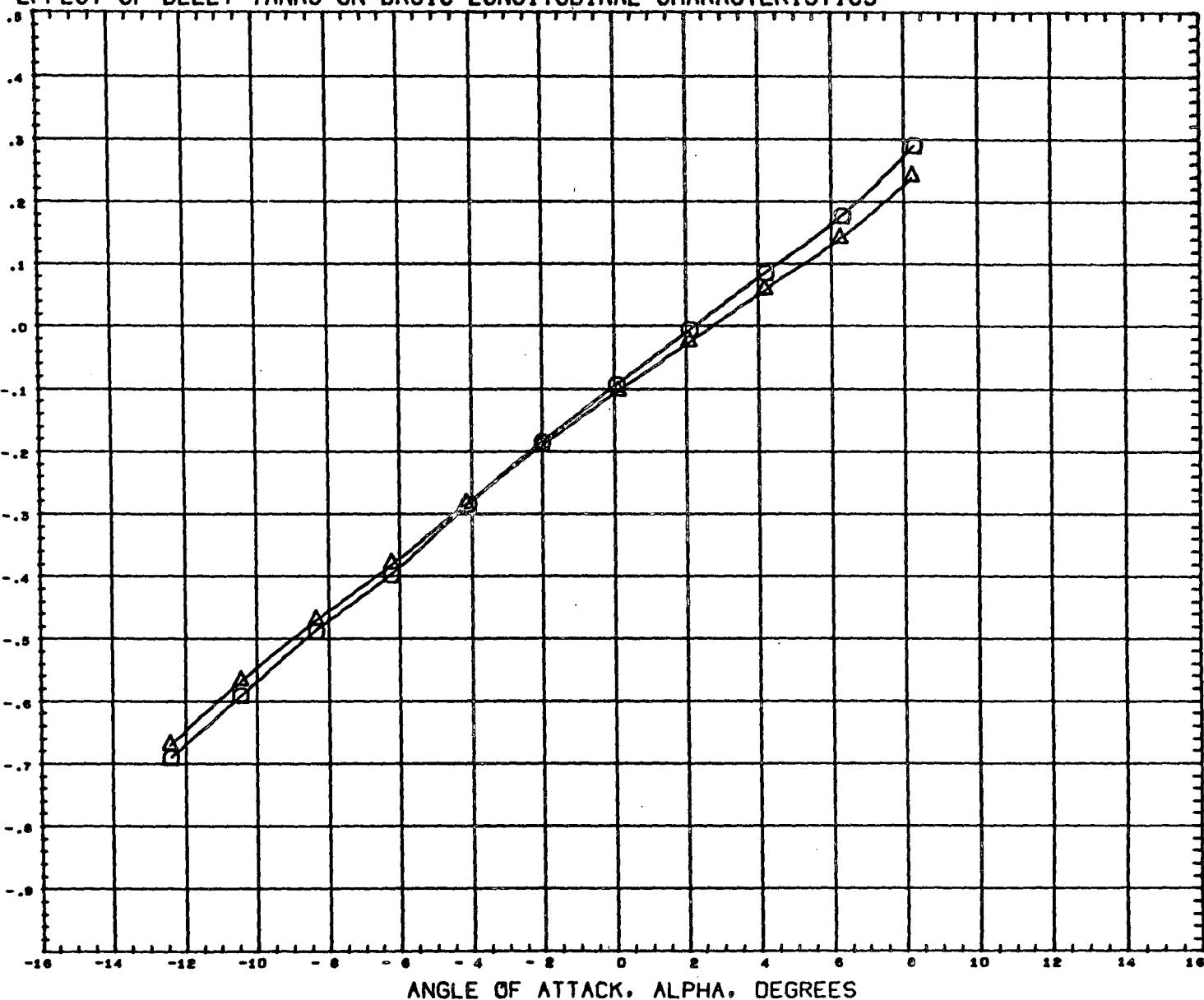
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# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

NORMAL FORCE COEFFICIENT, CN



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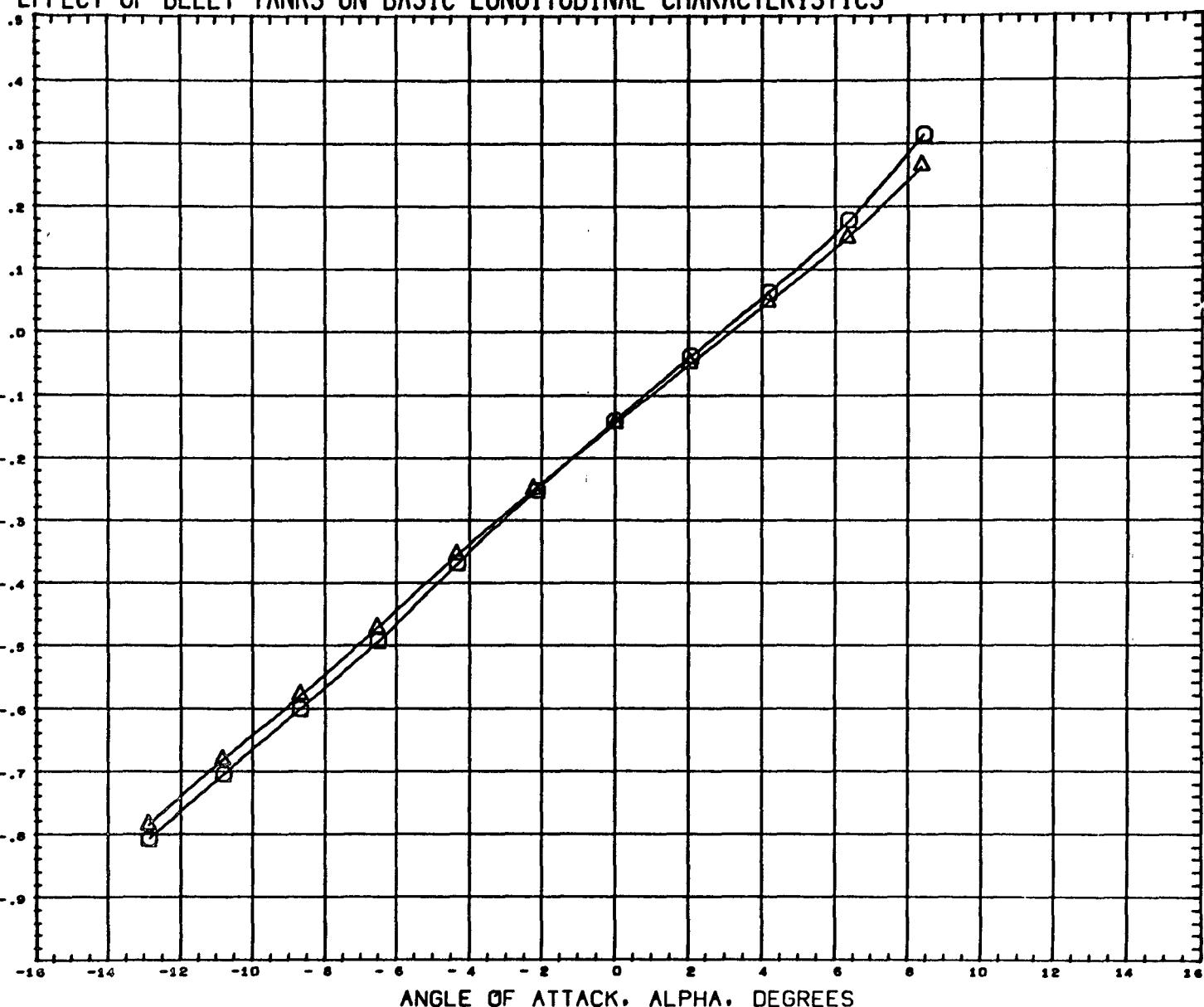
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MACH 0.605

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

NORMAL FORCE COEFFICIENT, CN



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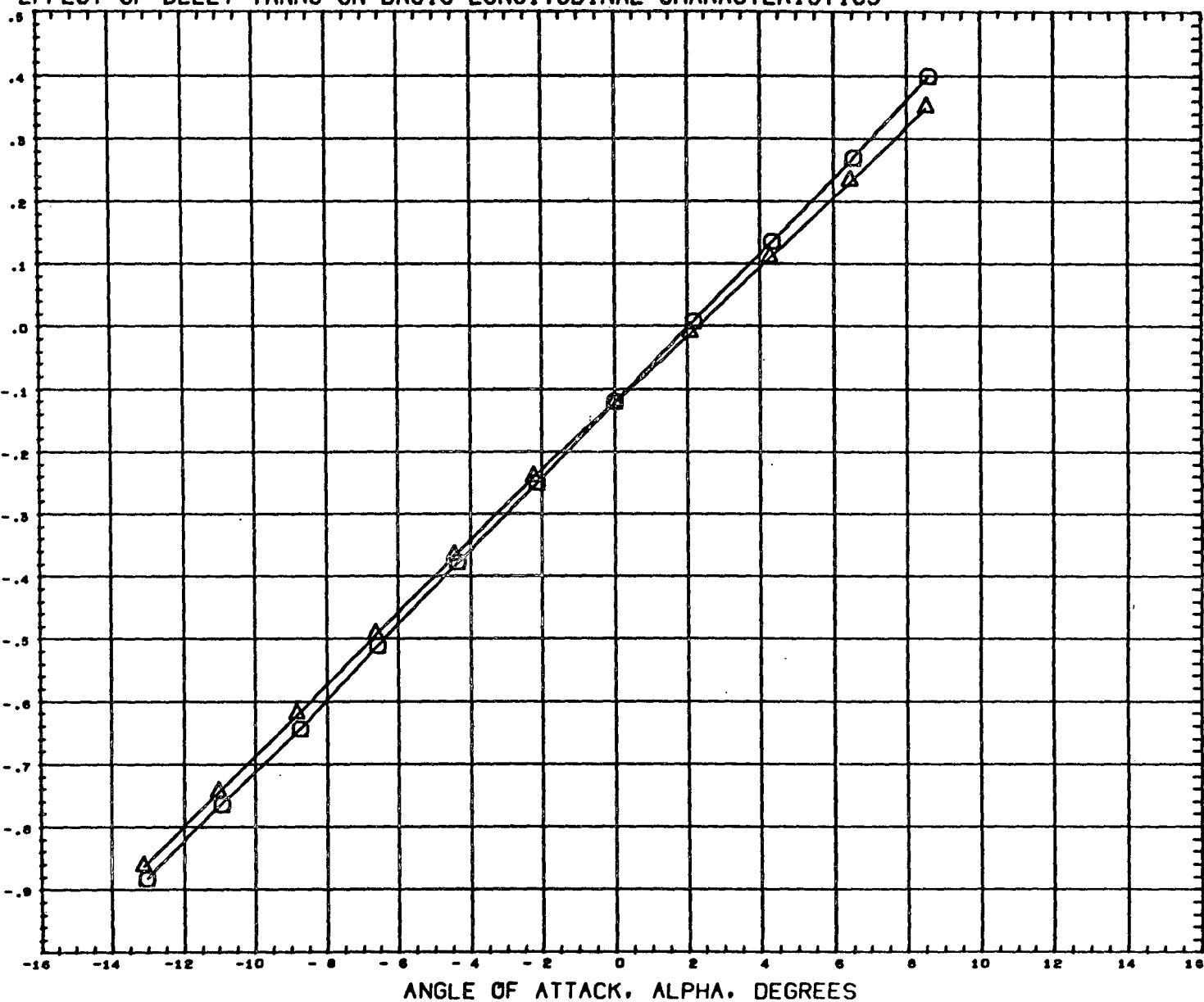
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MACH 0.698

PAGE 53

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

NORMAL FORCE COEFFICIENT, CN



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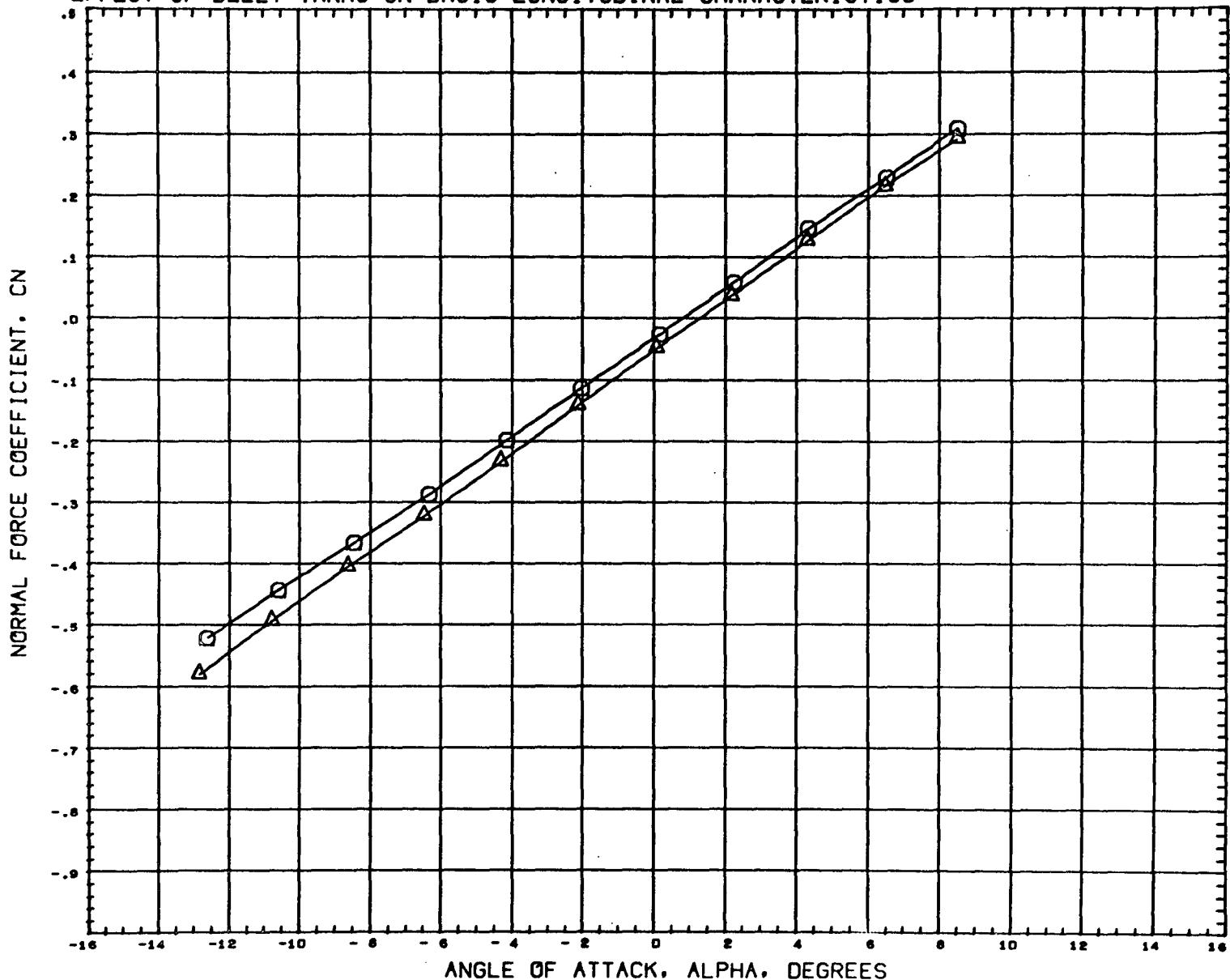
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MACH 1.194

PAGE 54

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



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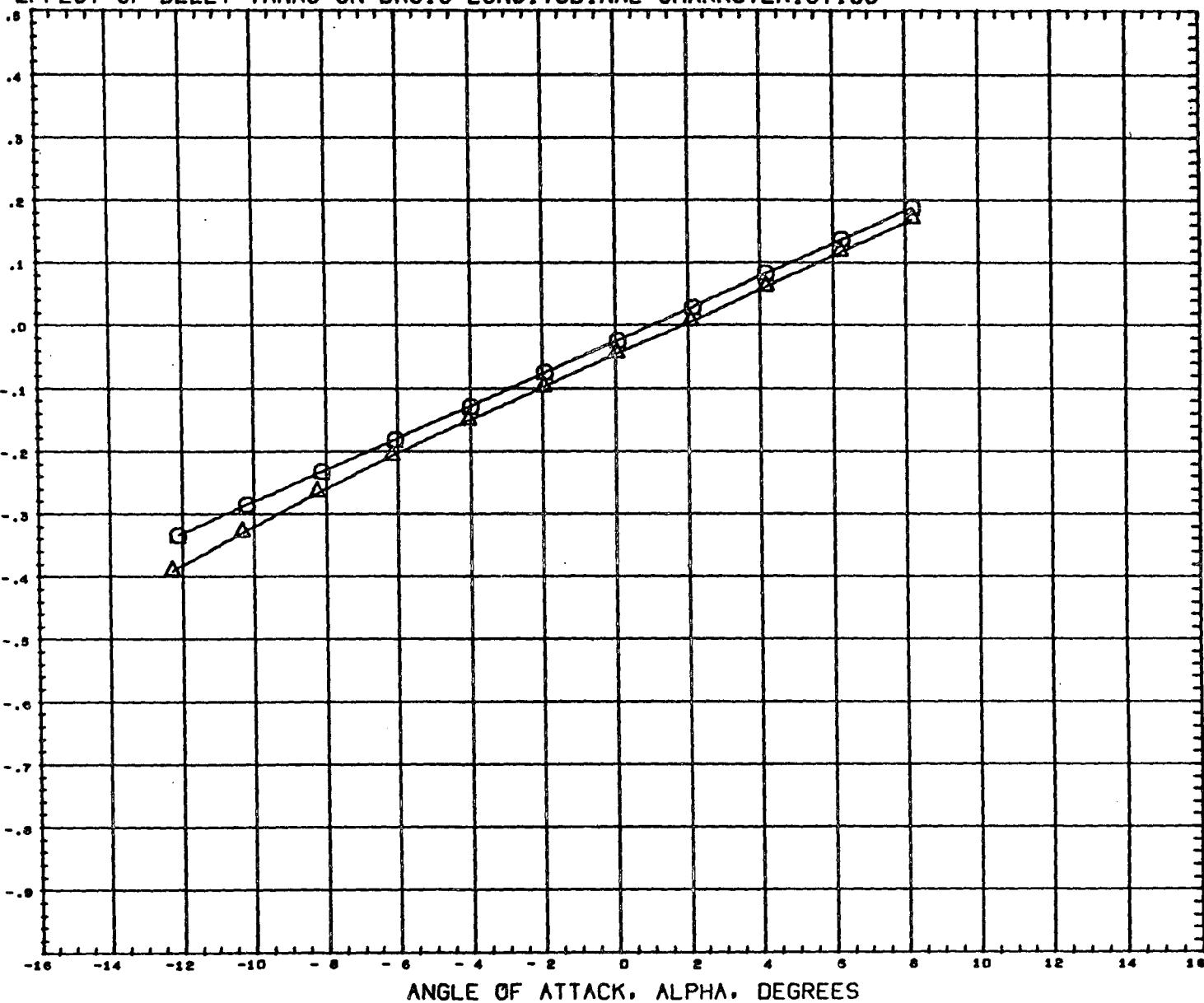
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SCALE	0.0044	SCALE

MACH 1.961

PAGE 55

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

NORMAL FORCE COEFFICIENT, CN



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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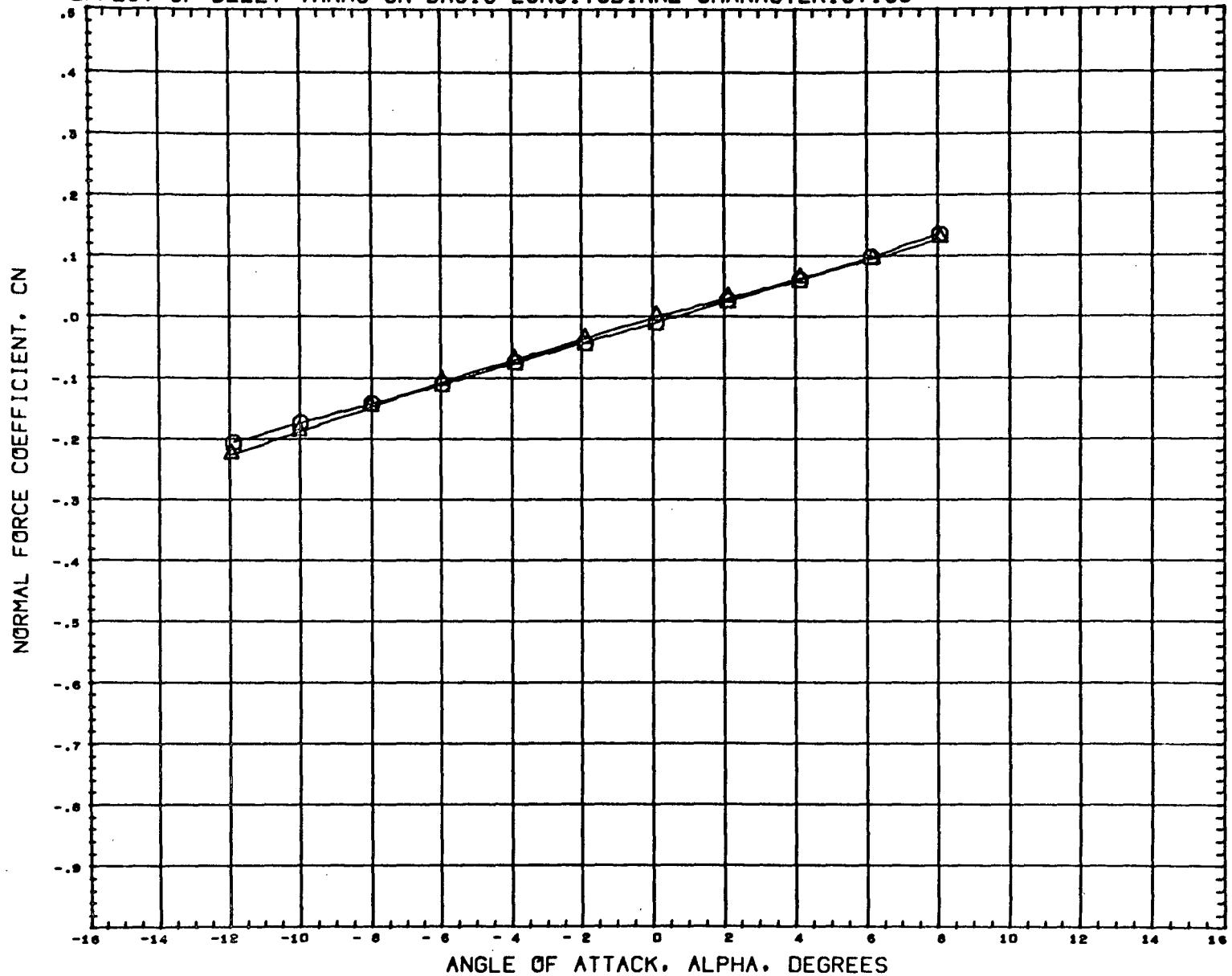
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 SCALE 0.0044 SCALE

MACH 2.000

PAGE 56

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



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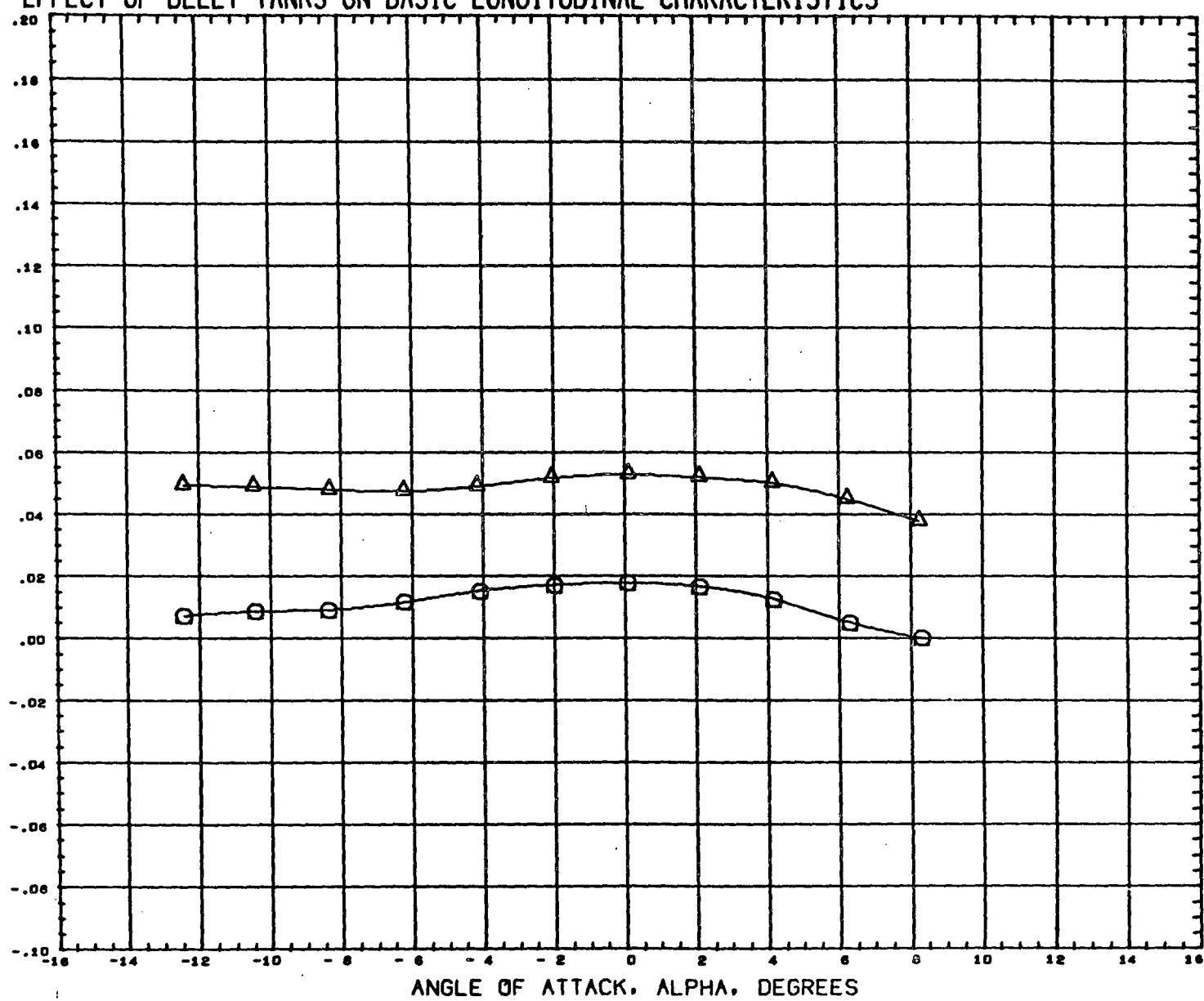
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MACH 4.059

PAGE 57

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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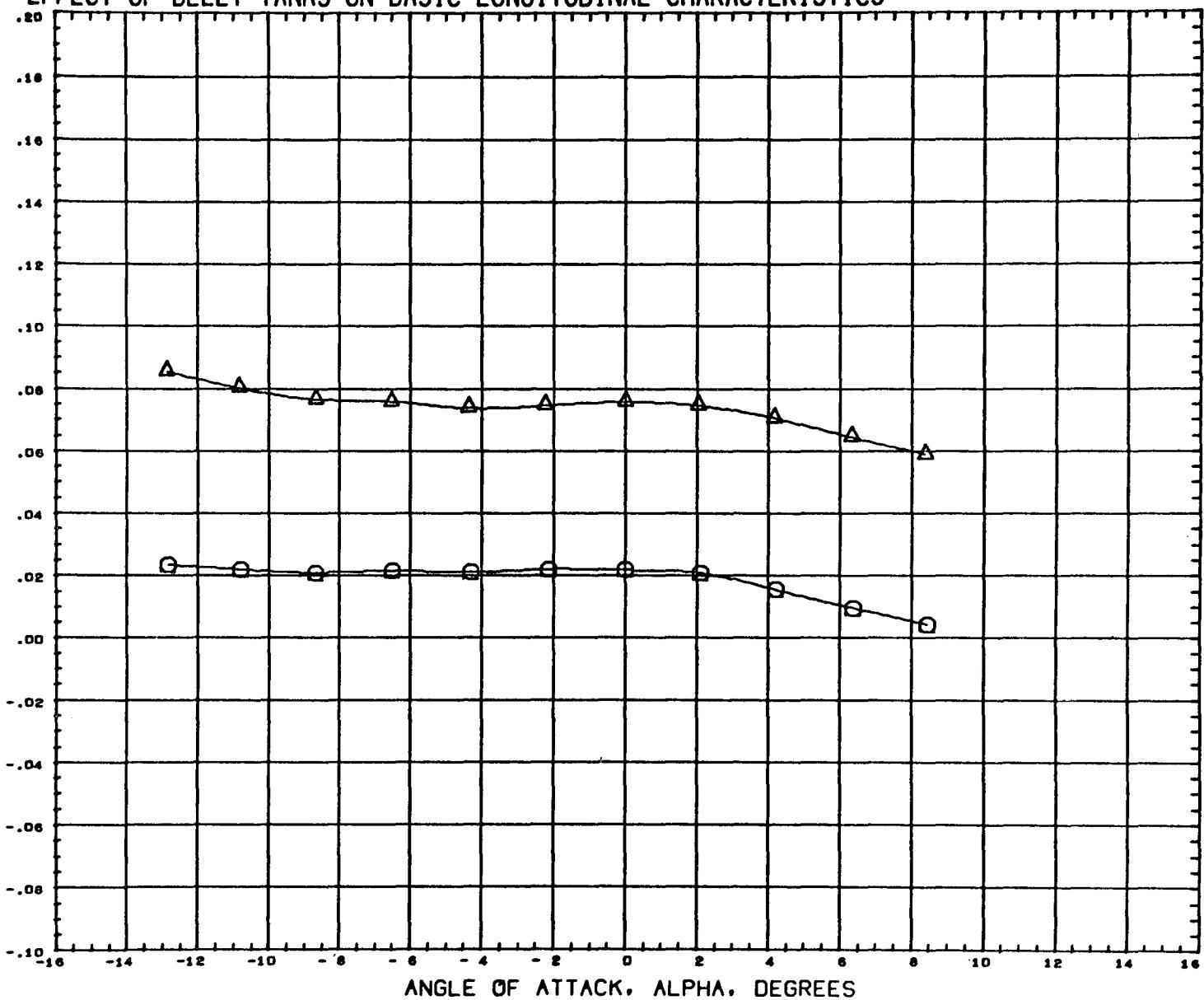
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 SCALE 0.0044 SCALE

MACH 0.605

PAGE 58

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT. CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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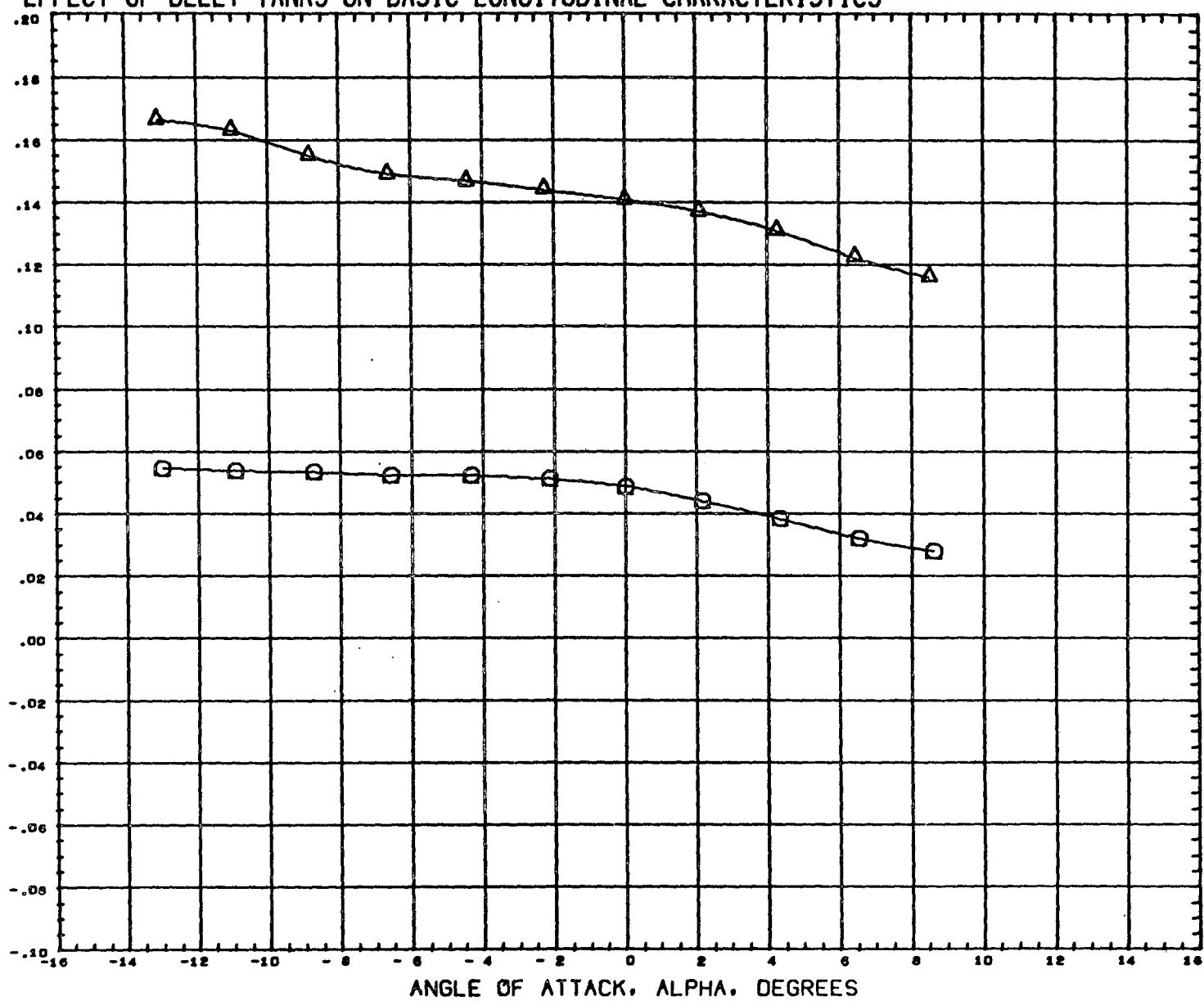
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 SCALE 0.0044 SCALE

MACH 0.898

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT. CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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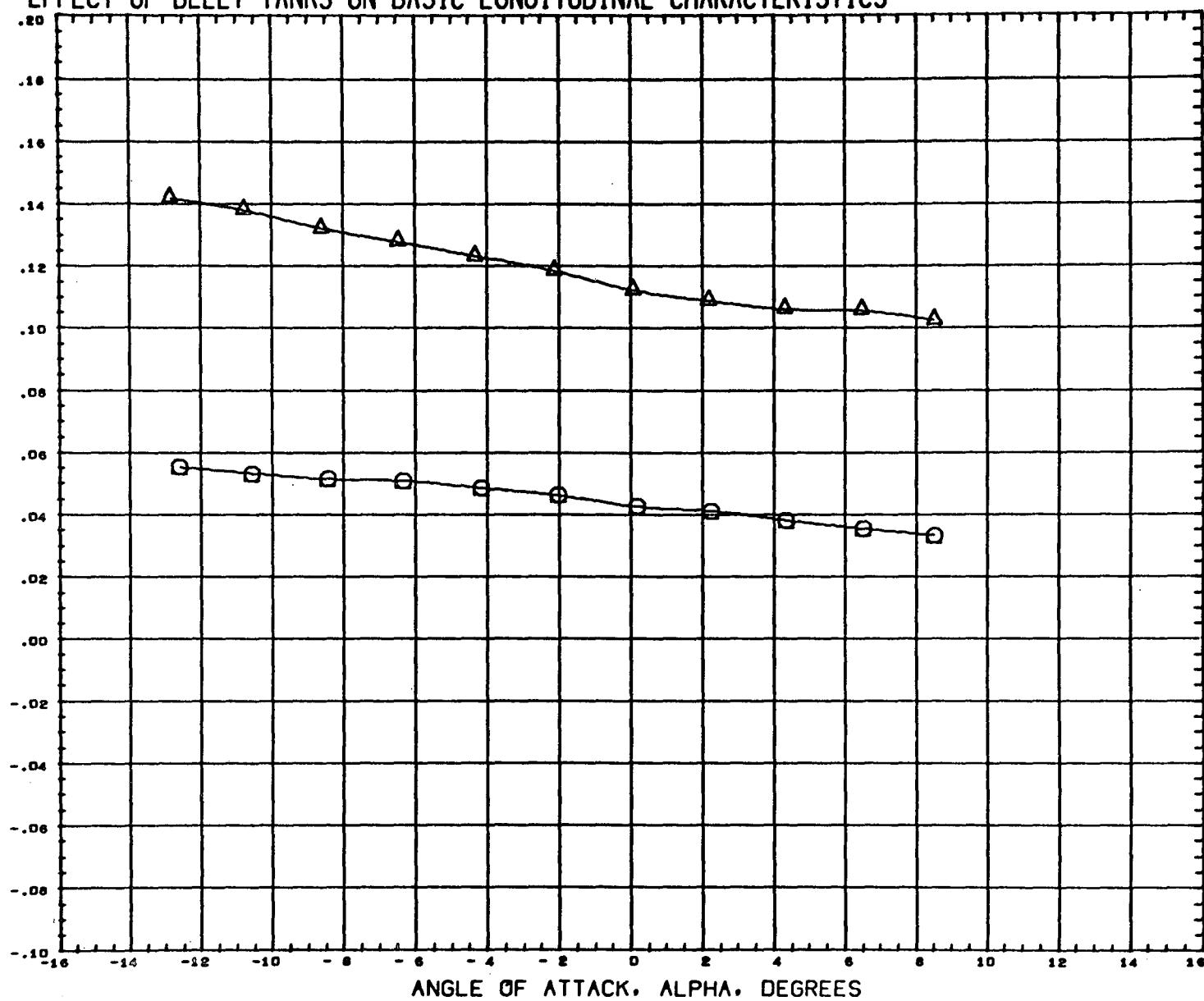
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 SCALE 0.0044 SCALE

MACH 1.194

PAGE 60

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(J5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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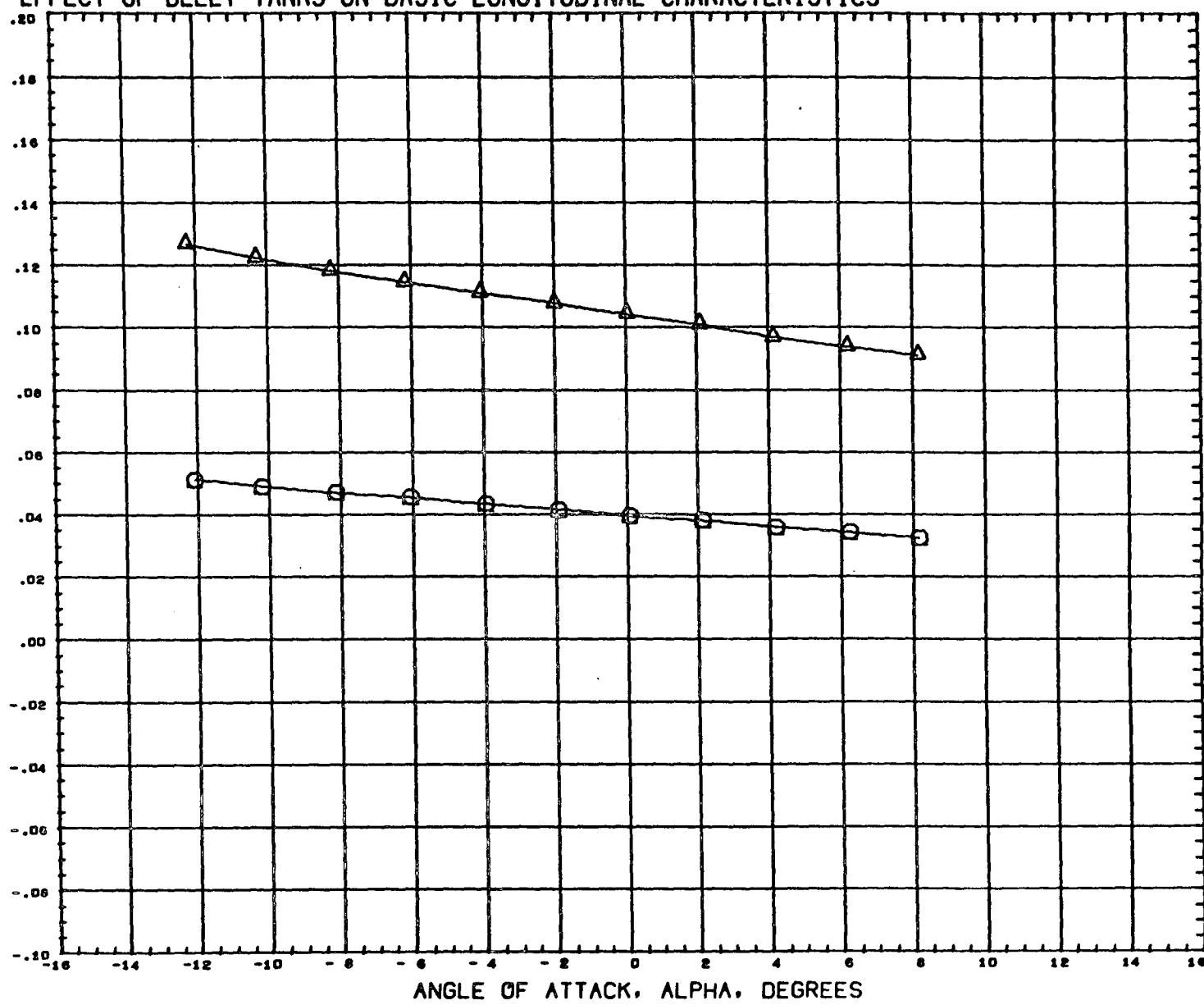
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SCALE	0.0044	SCALE

MACH 1.961

PAGE 61

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT, CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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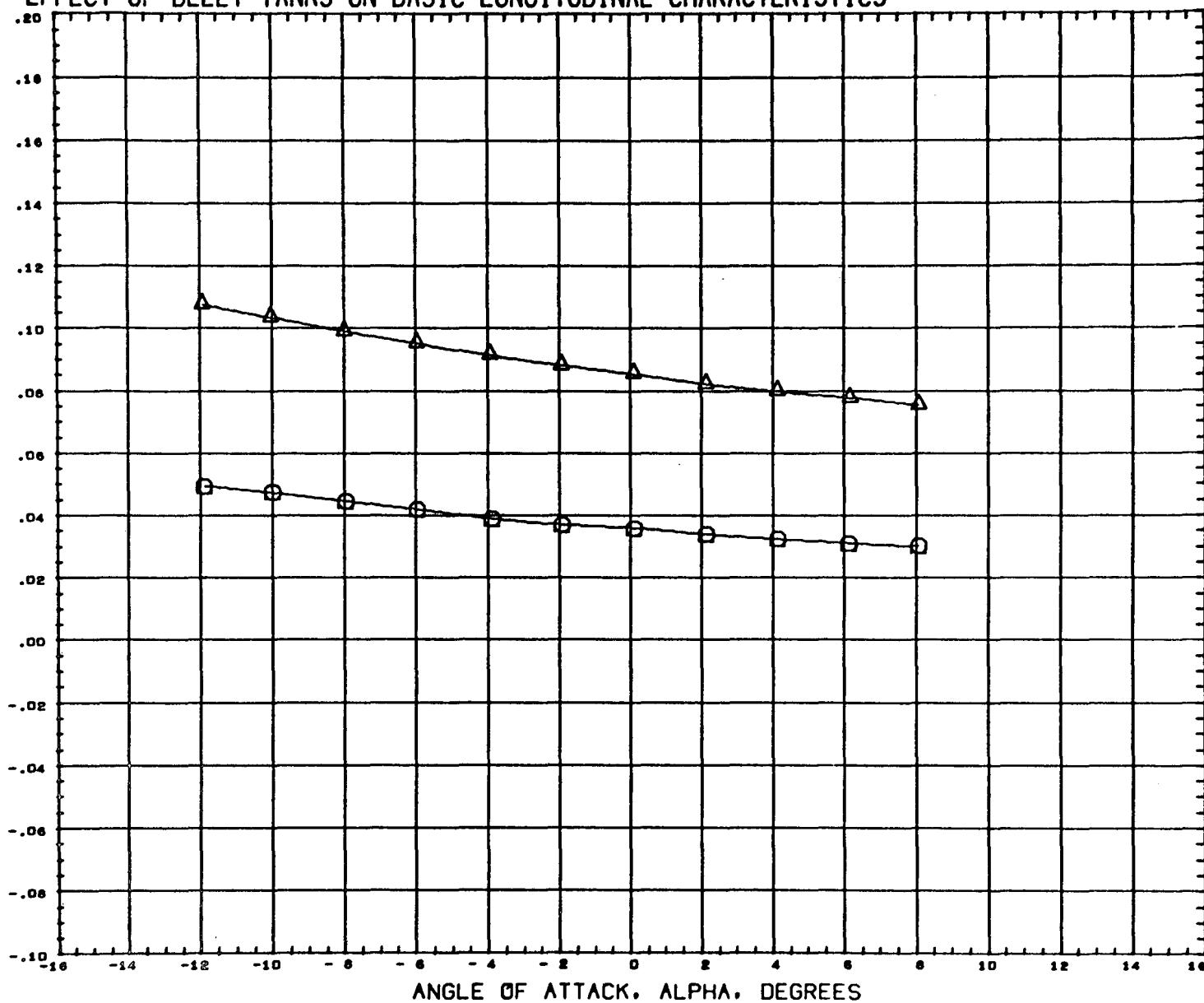
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MACH 2.990

PAGE 62

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY AXIAL FORCE COEFFICIENT. CAF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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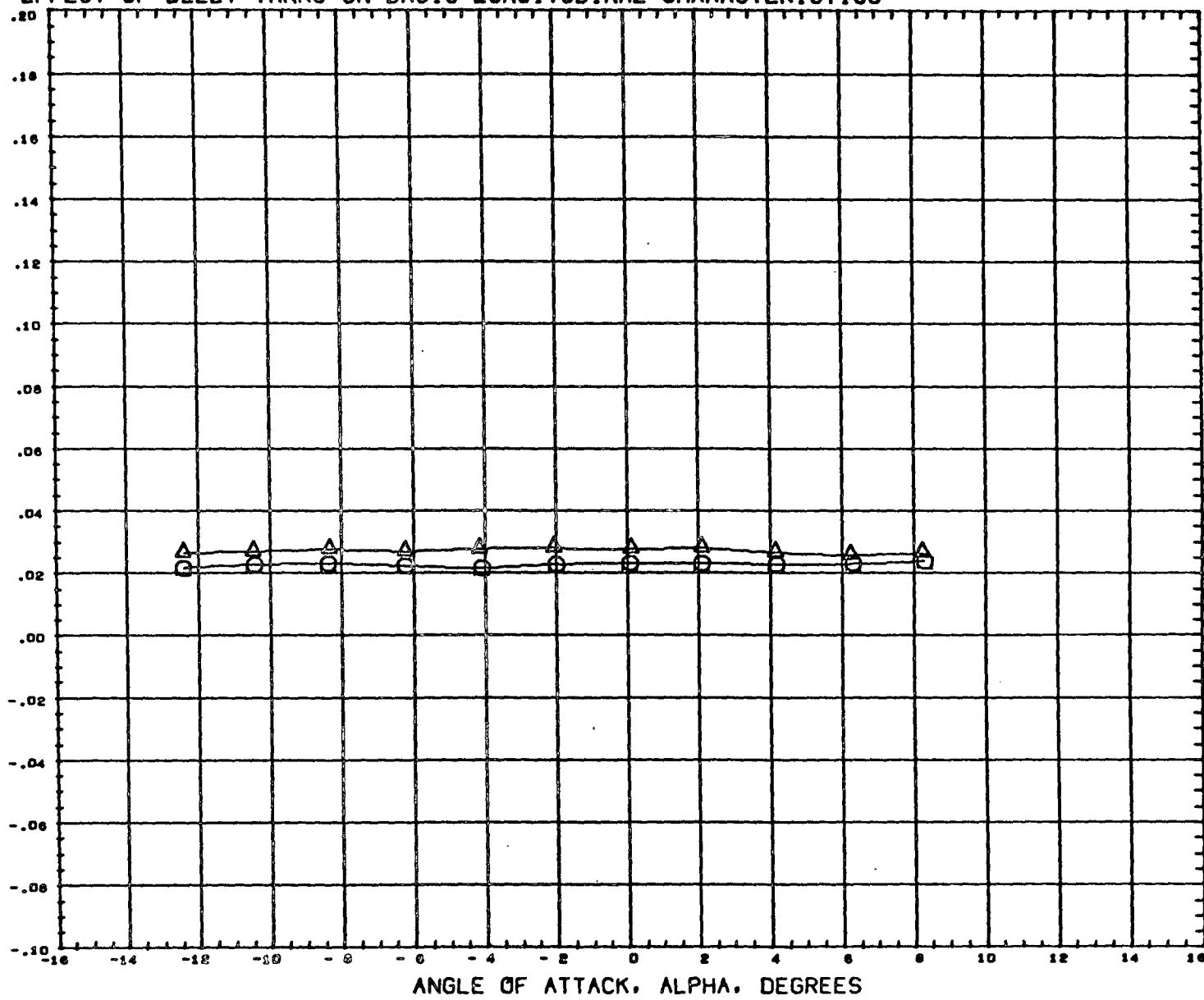
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MACH 4.959

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



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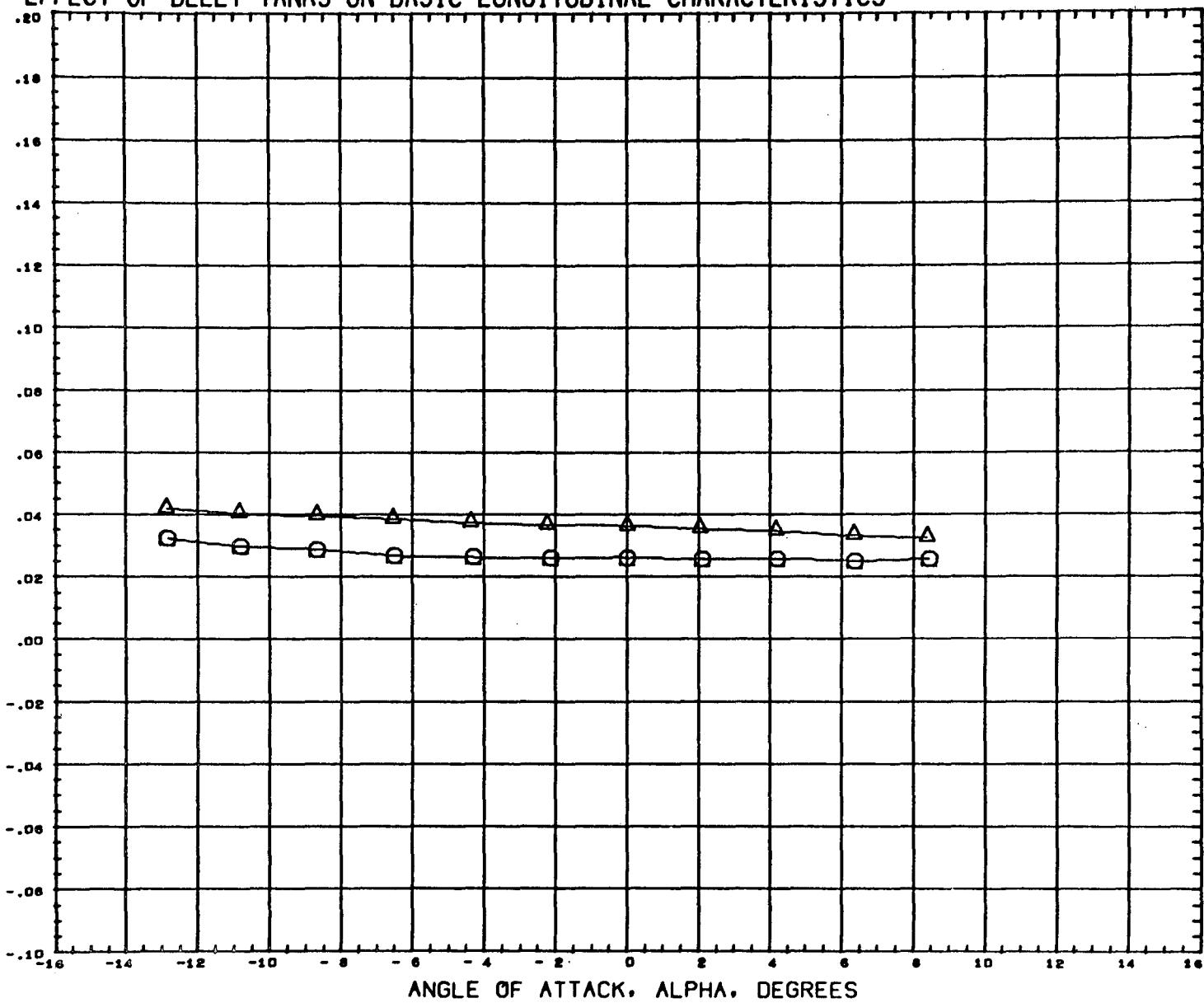
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MACH 0.003

PAGE 64

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



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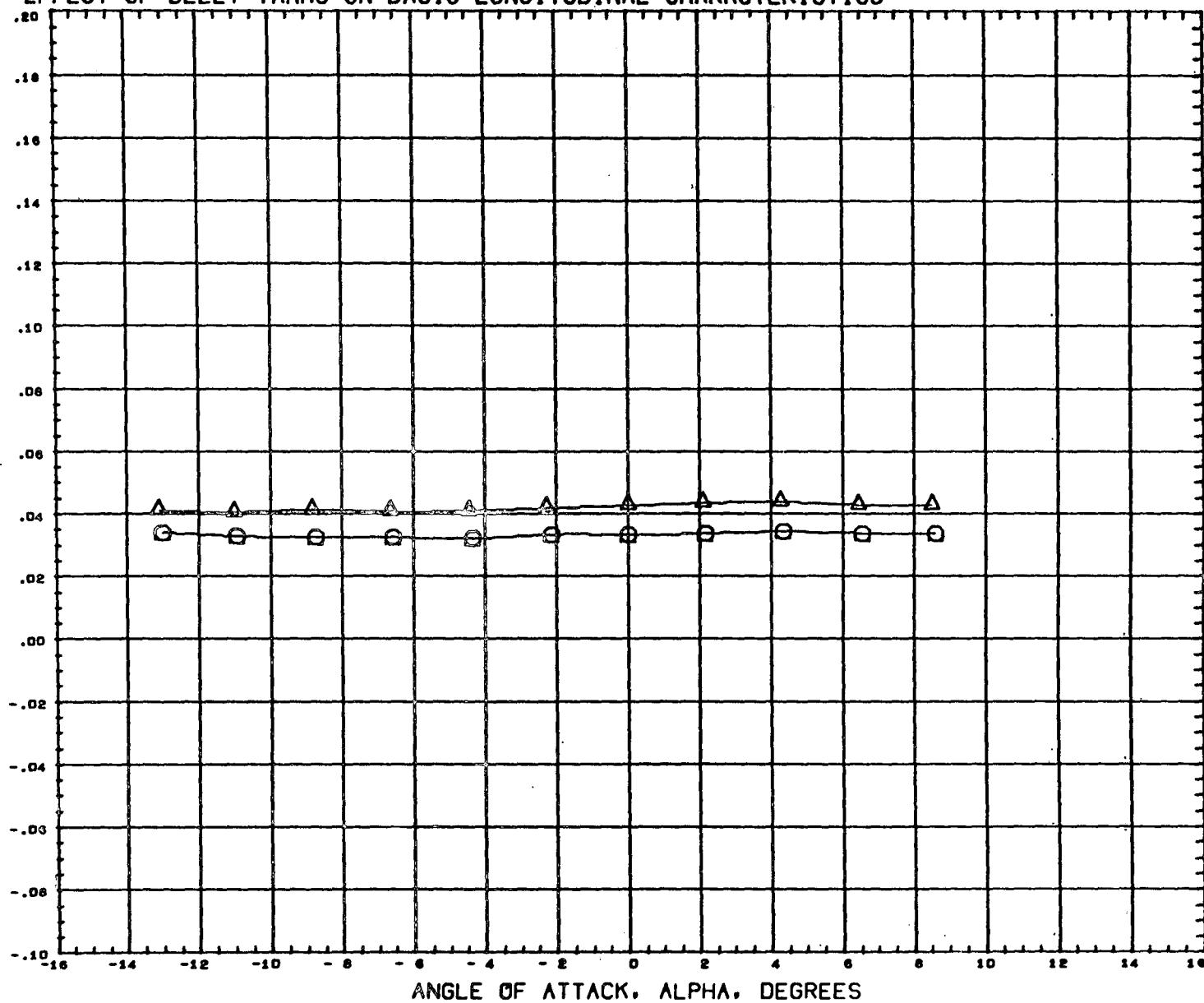
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SCALE	0.0044	SCALE

MACH 0.898

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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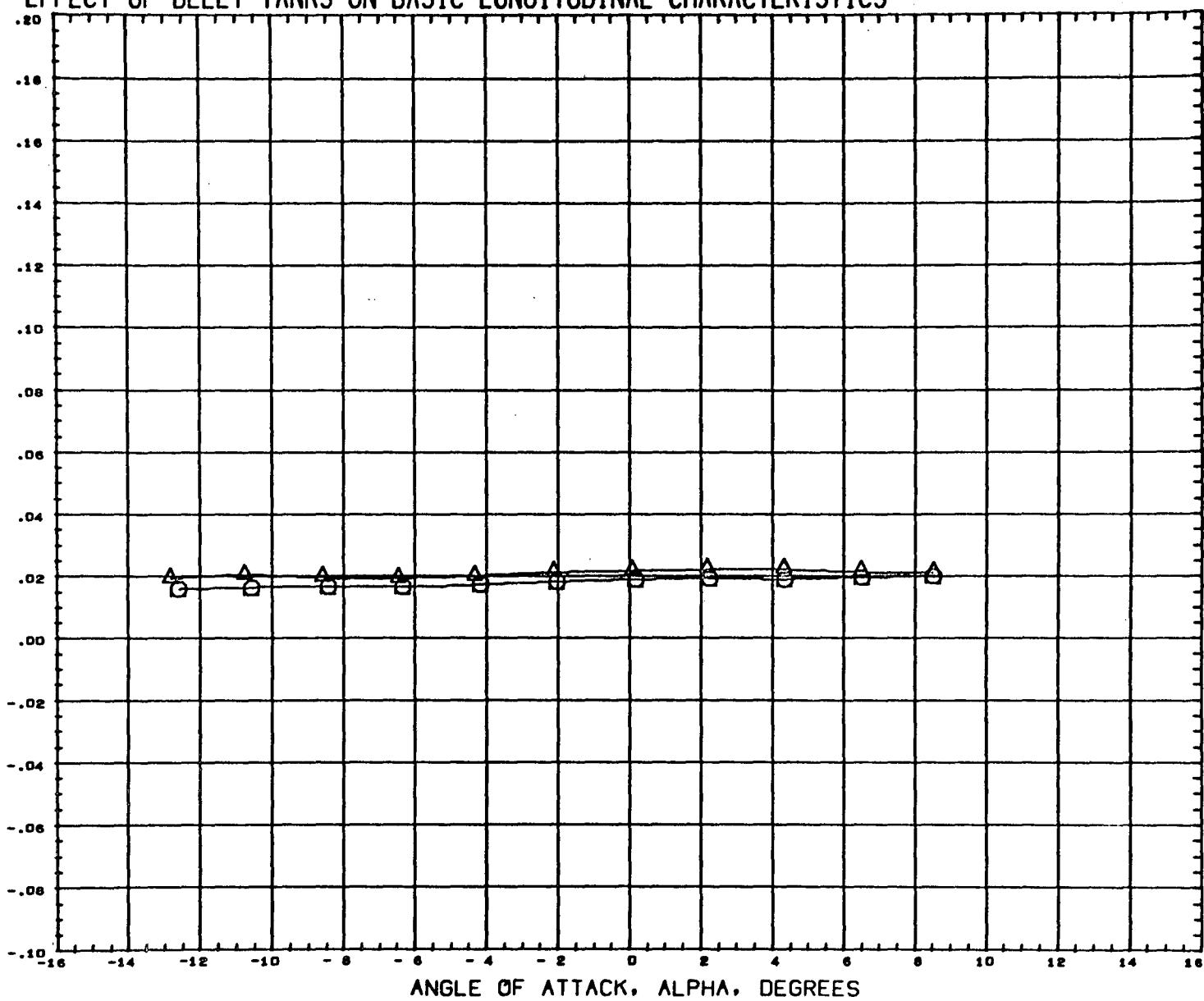
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MACH 1.194

PAGE 66

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



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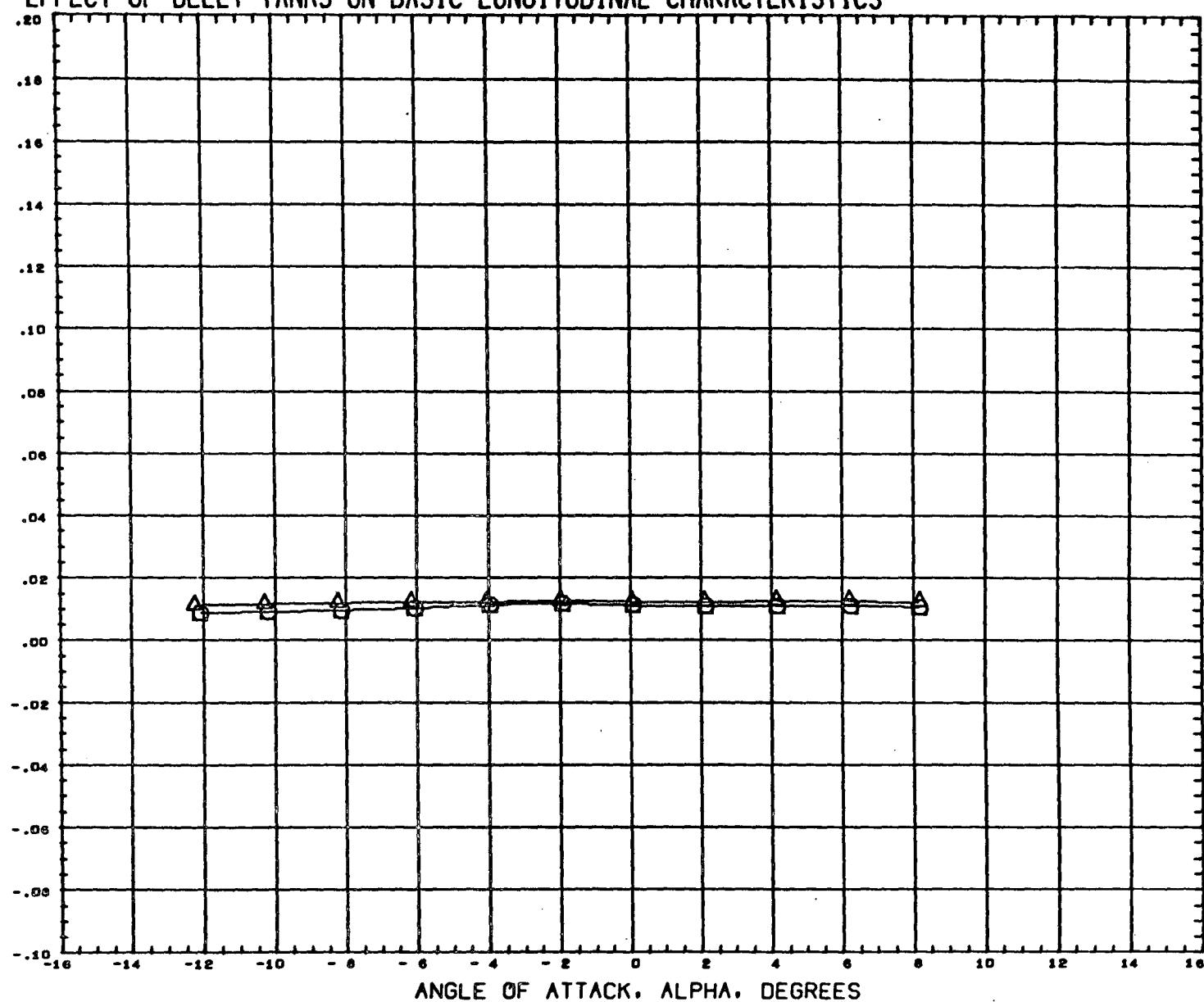
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 SCALE 0.0044 SCALE

MACH 1.961

PAGE 67

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



DATA SET SYMBOL CONFIGURATION DESCRIPTION

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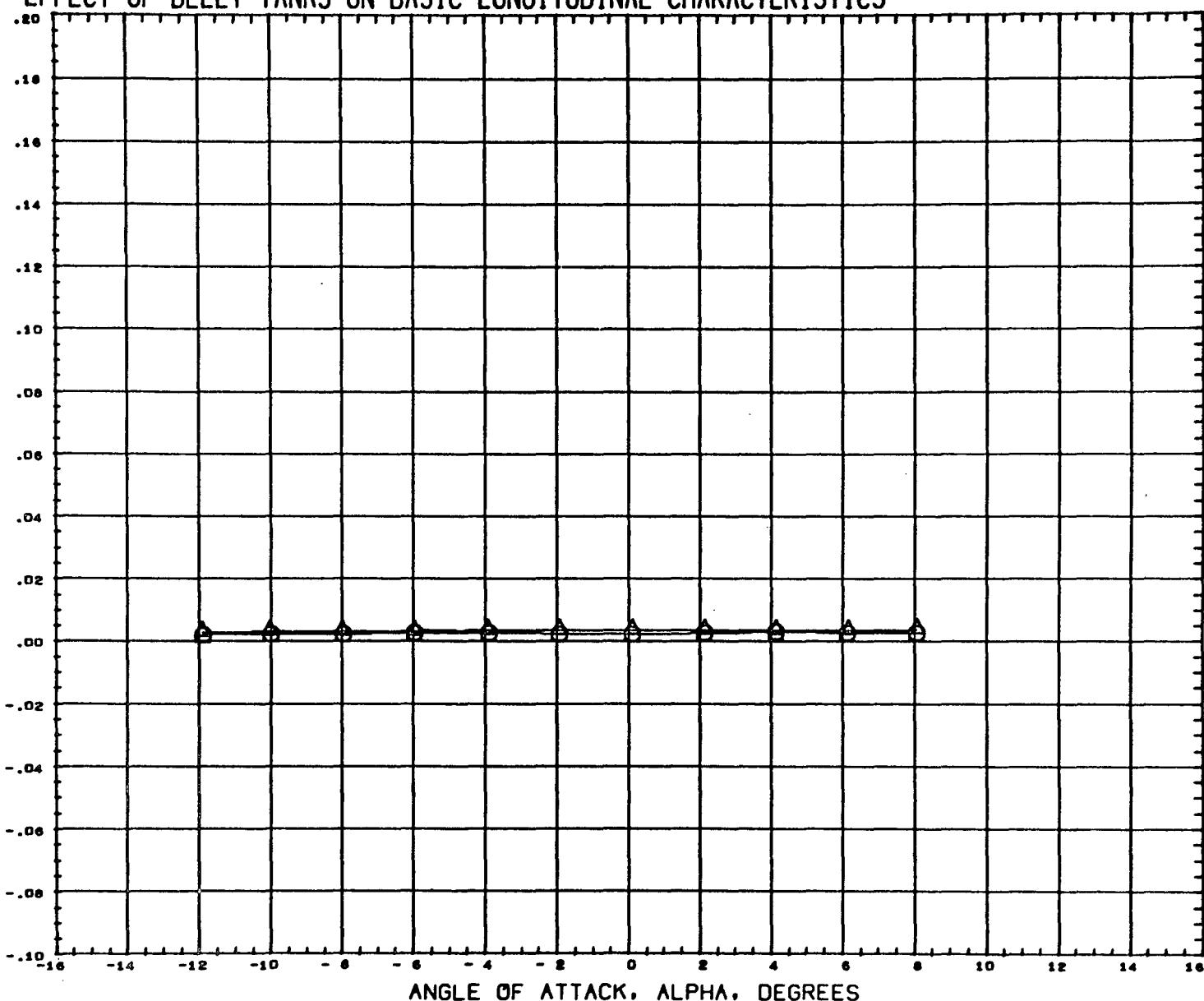
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SCALE	0.0044	SCALE

MACH 2.990

PAGE 68

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

BASE AXIAL FORCE COEFFICIENT, CAB



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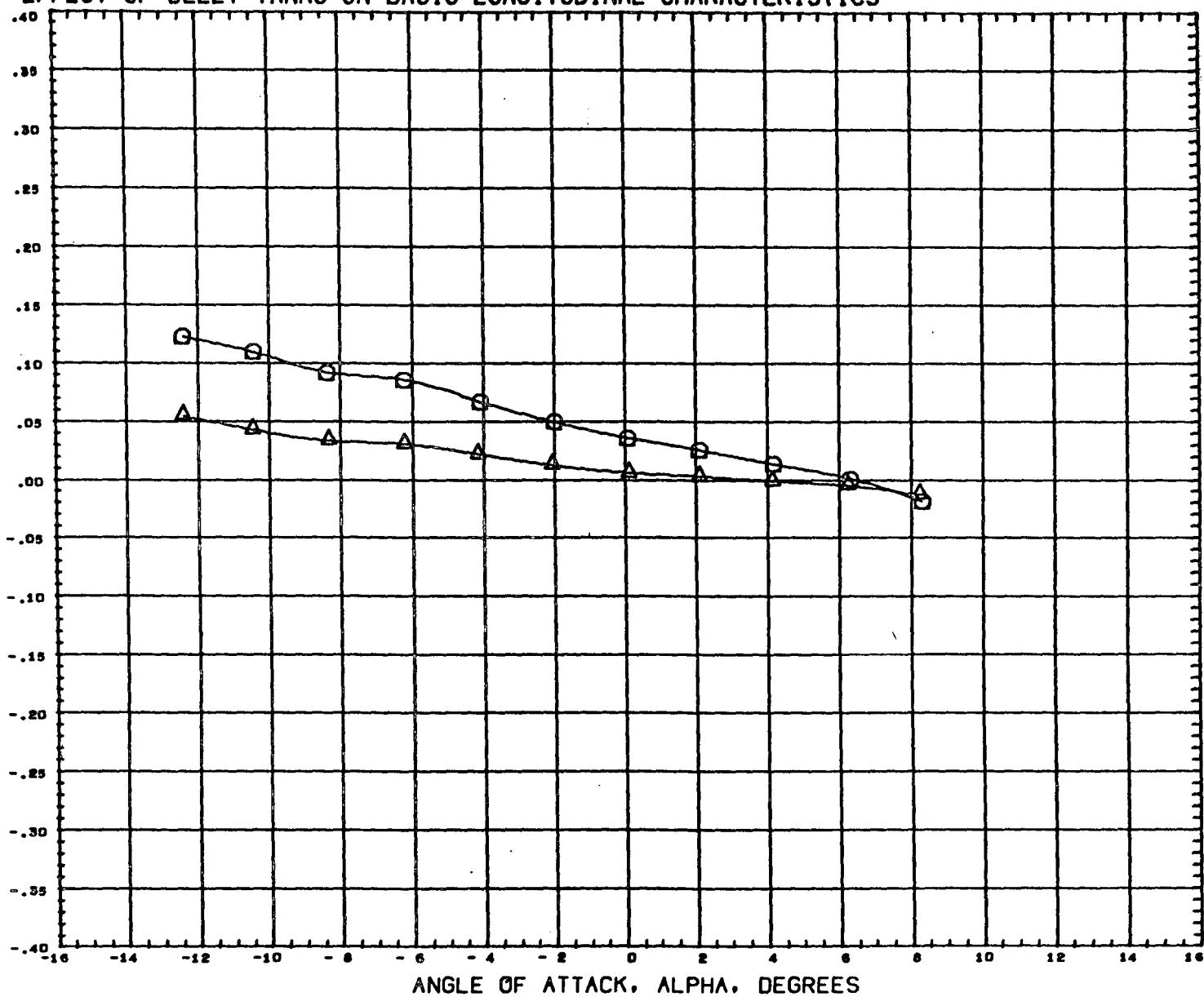
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MACH 4.959

PAGE 69

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

PITCHING MOMENT COEFFICIENT, CLM



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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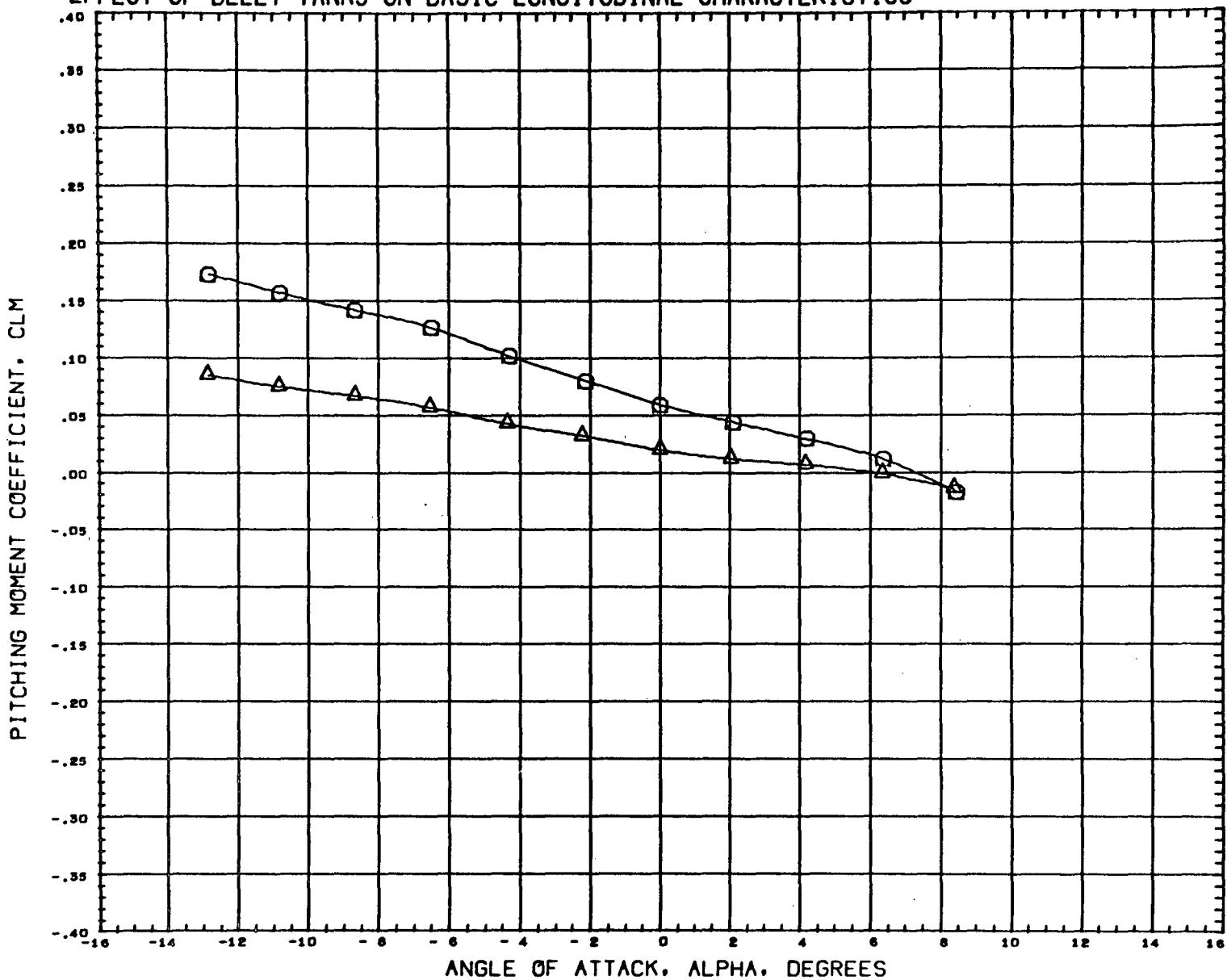
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MACH 0.605

PAGE 70

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



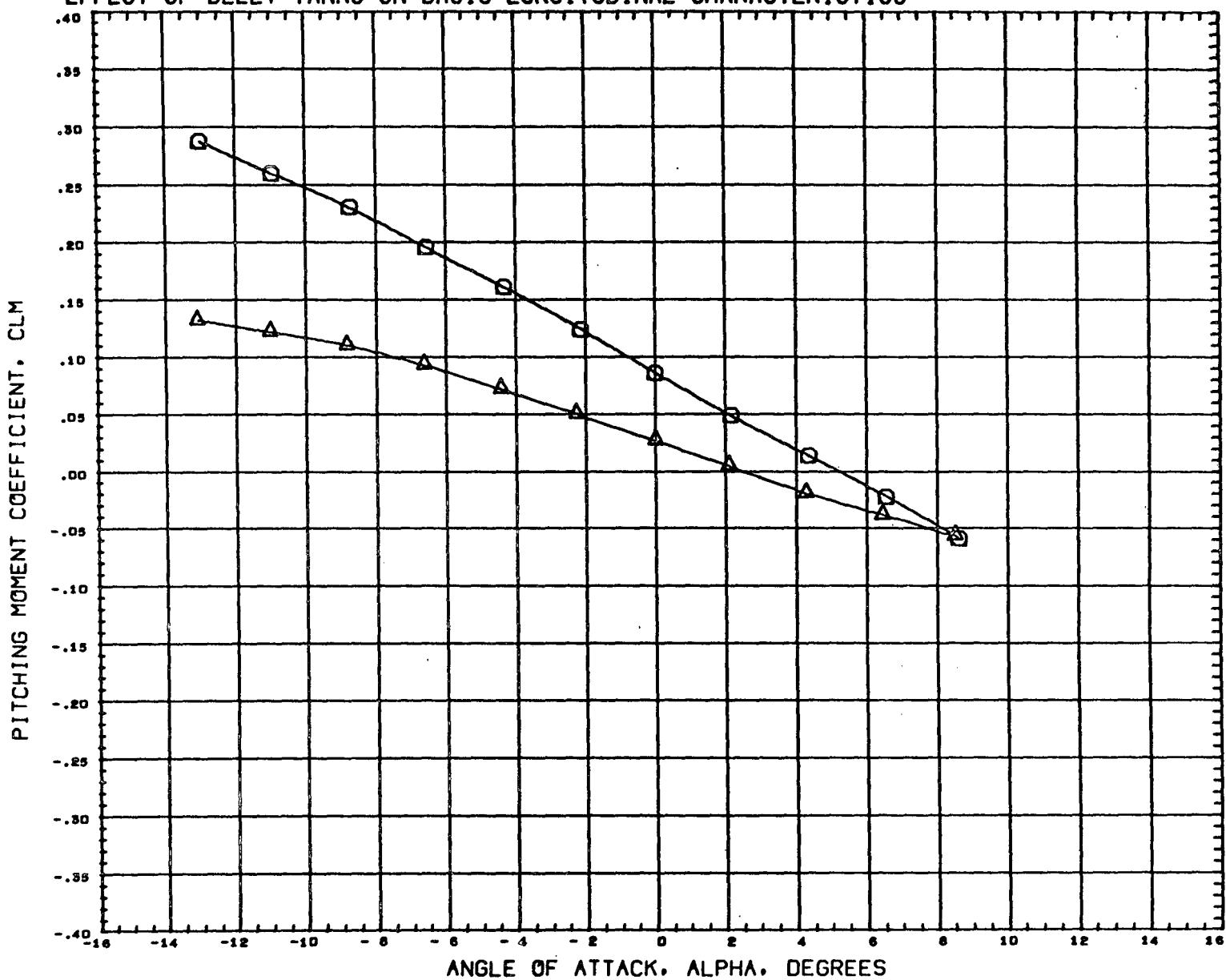
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MACH 0.898

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



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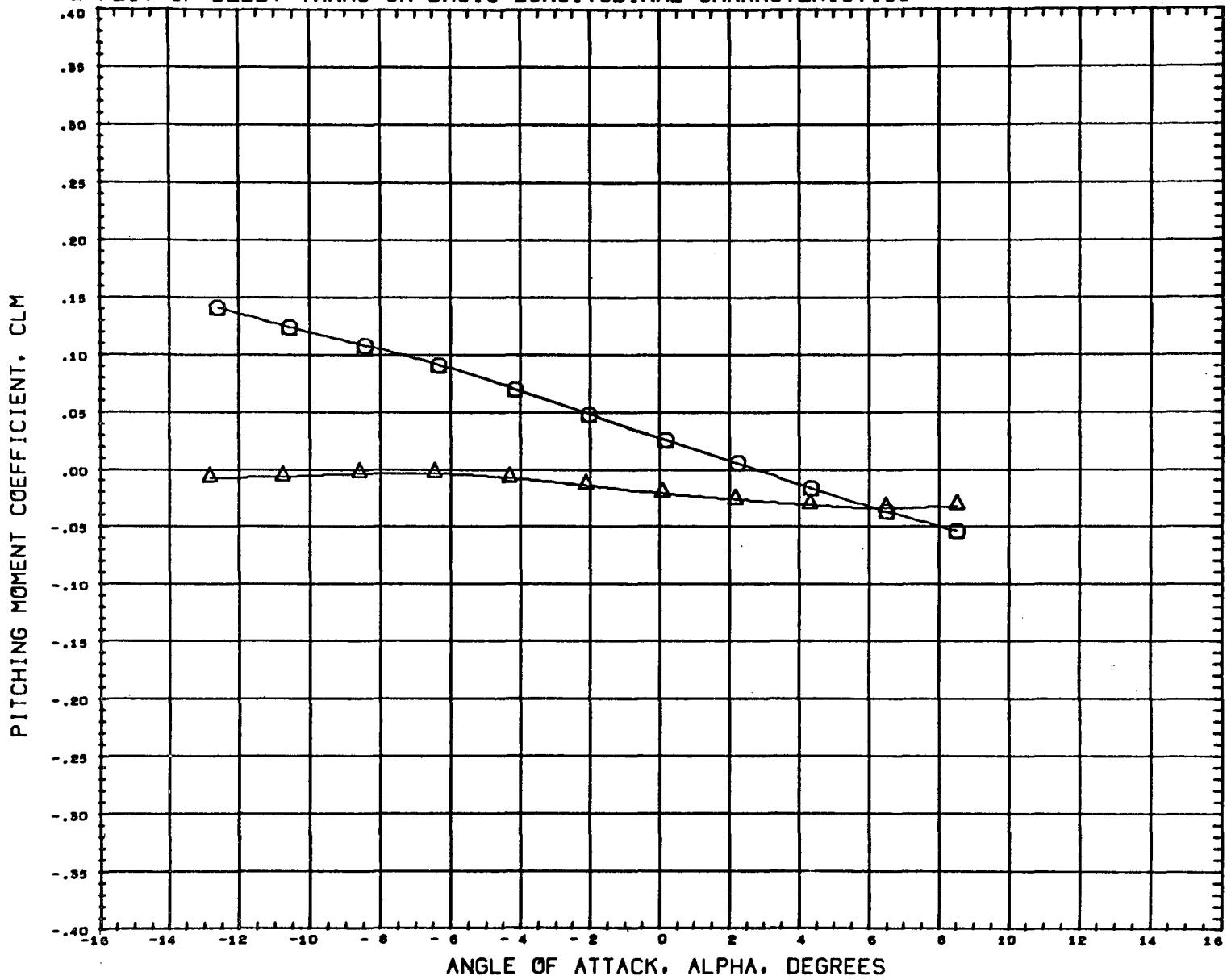
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 SCALE 0.0044 SCALE

MACH 1.194

PAGE 72

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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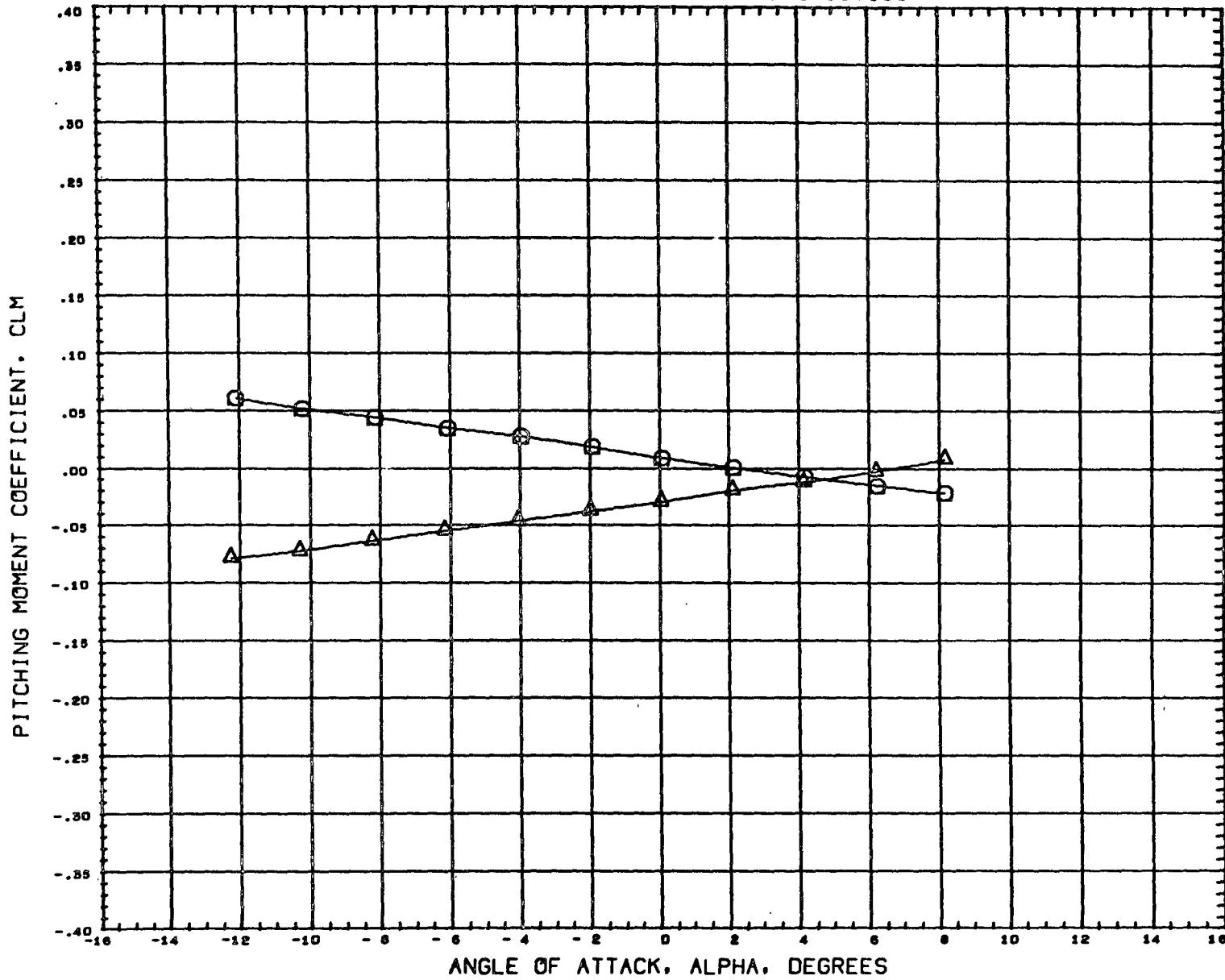
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 SCALE 0.0044 SCALE

MACH 1.961

PAGE 73

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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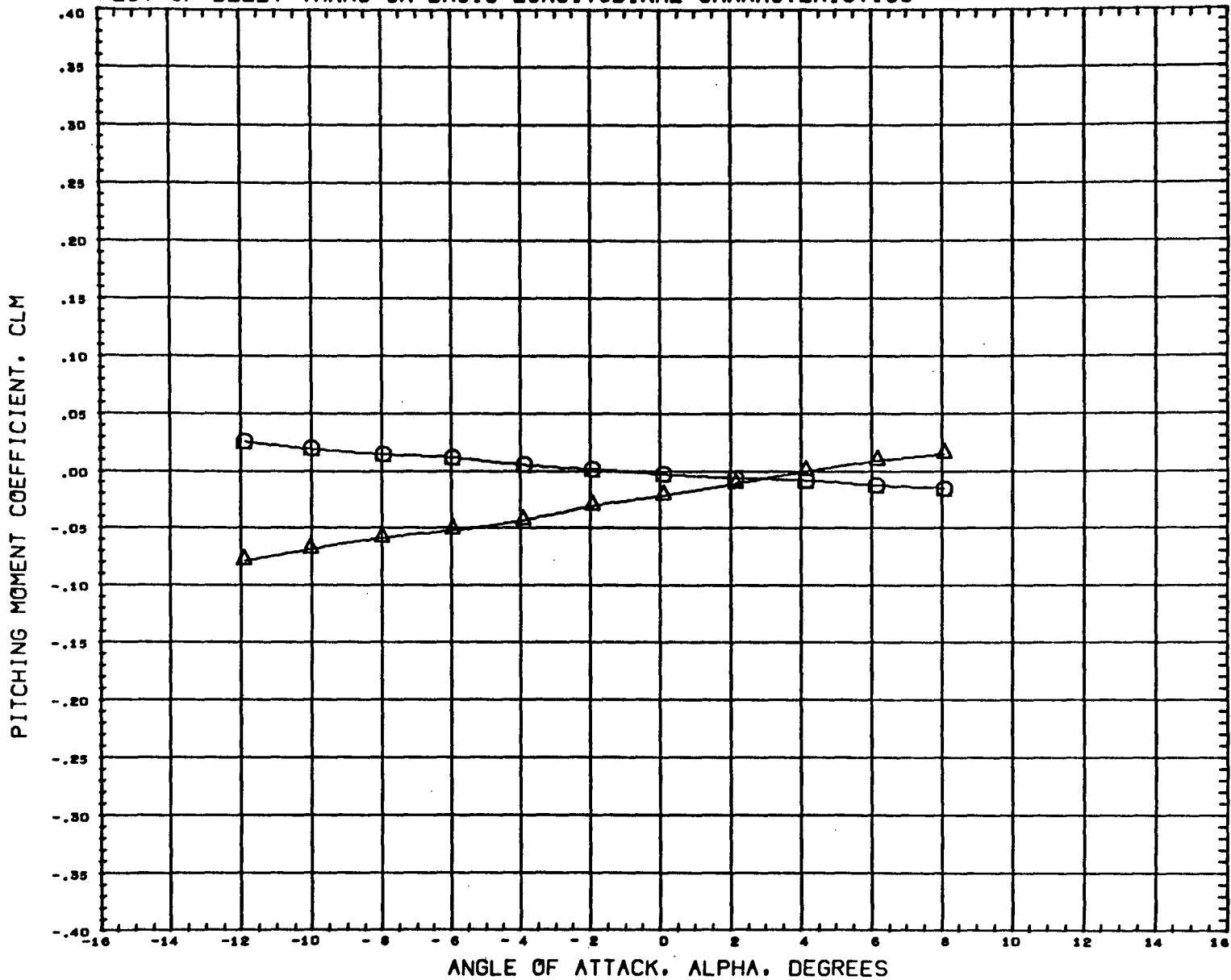
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MACH 2.090

PAGE 74

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



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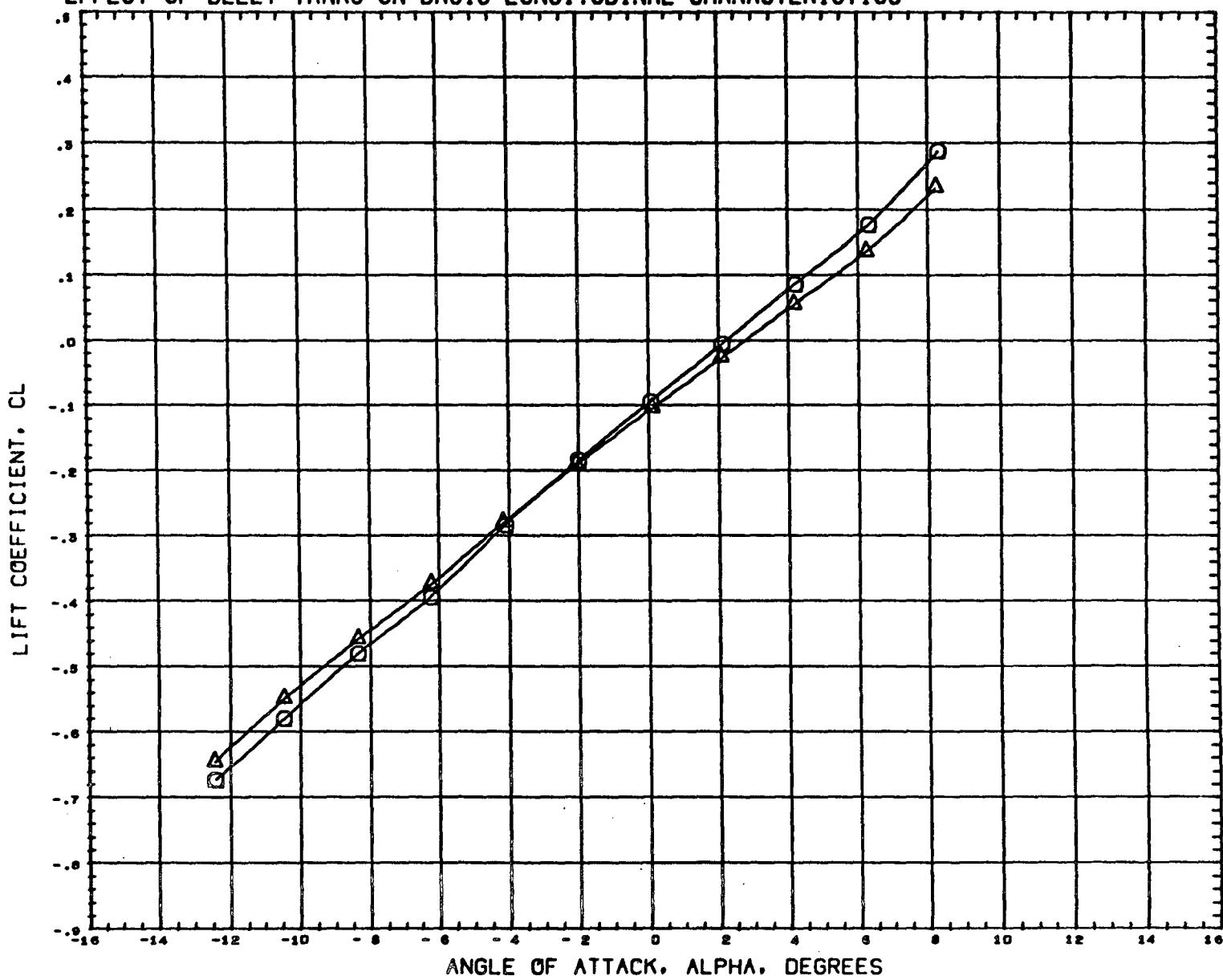
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MACH 4.059

PAGE 75

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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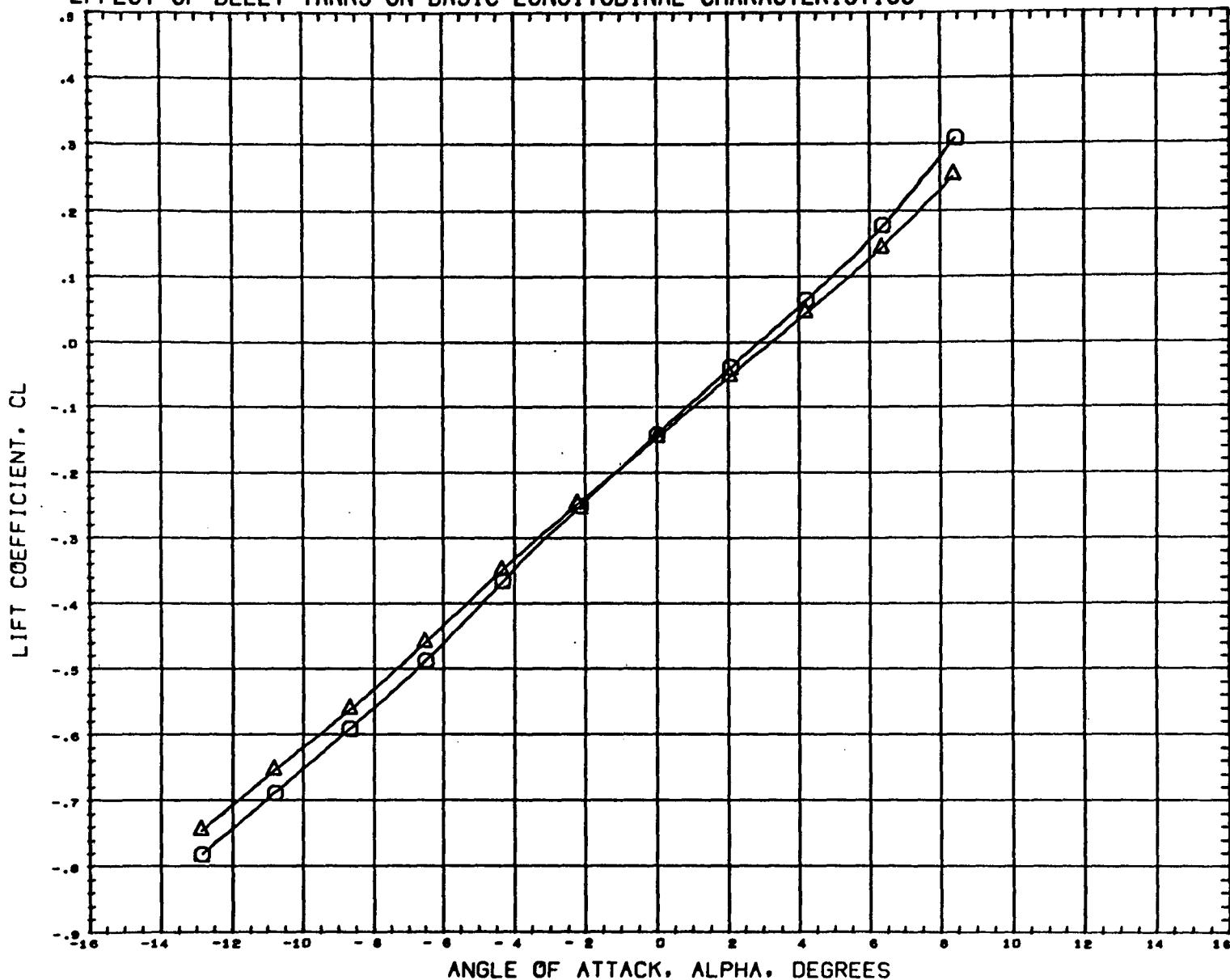
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MACH 0.605

PAGE 76

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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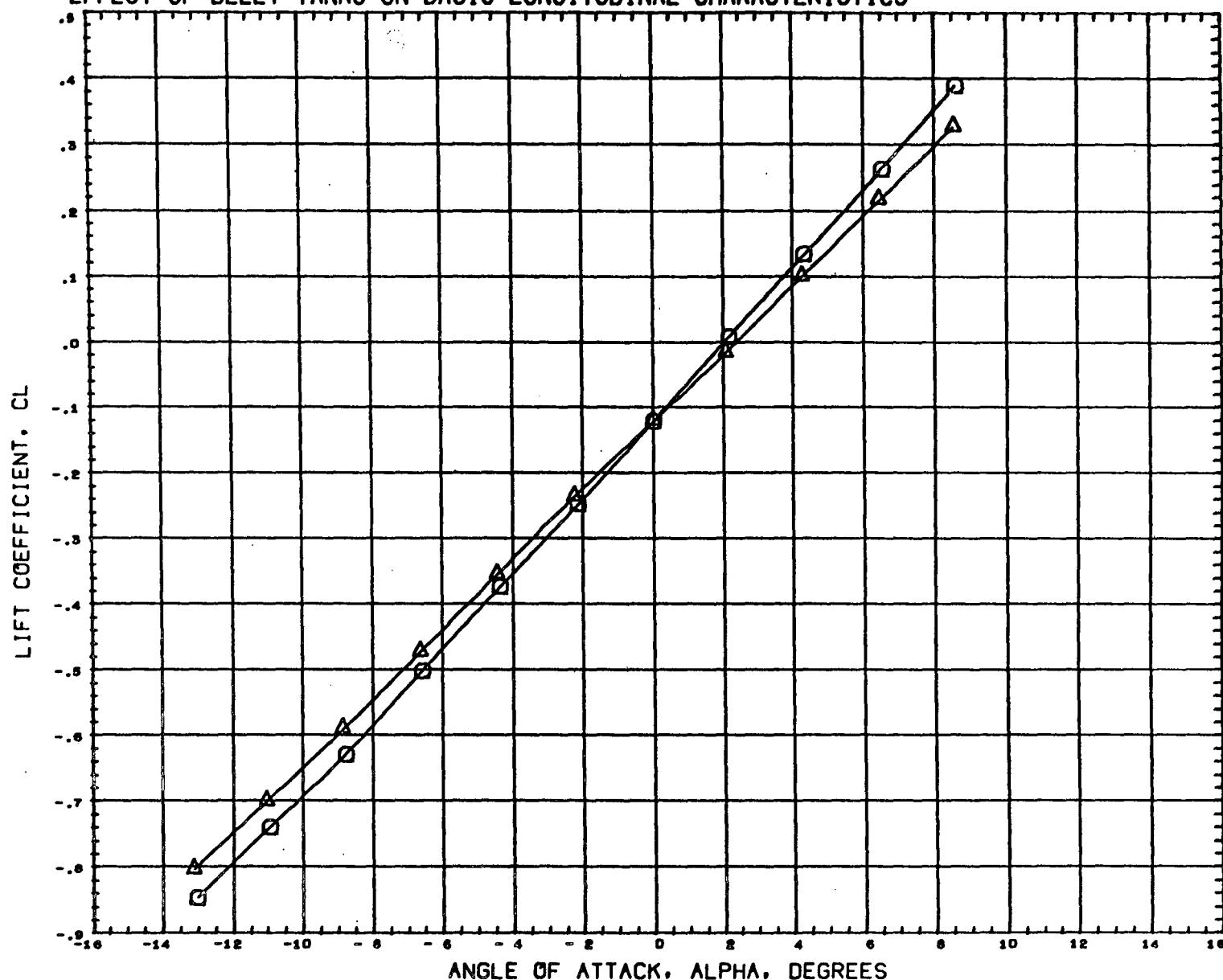
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MACH 0.898

PAGE 77

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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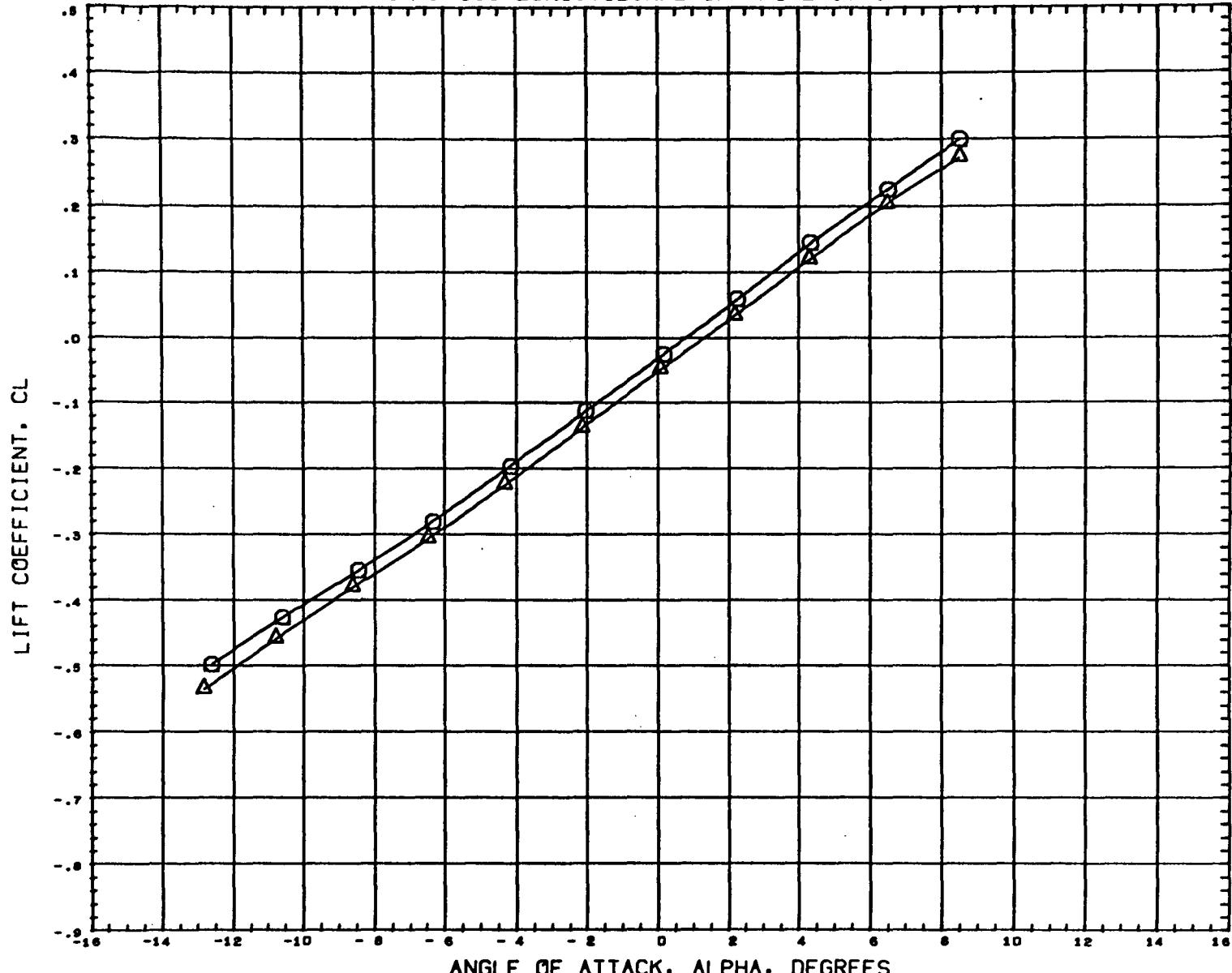
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MACH 1.194

PAGE 78

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL    CONFIGURATION DESCRIPTION  
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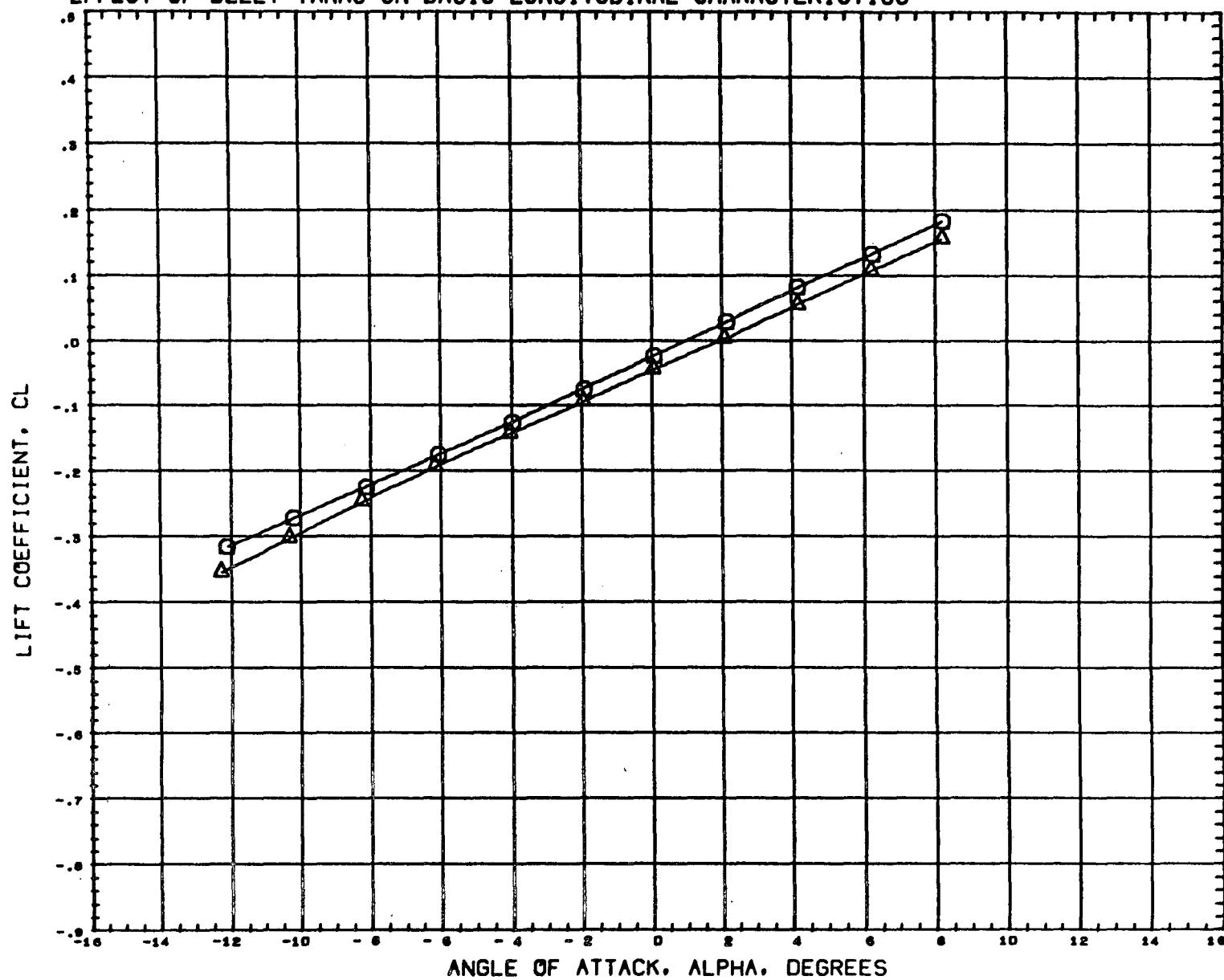
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MACH      1.961

PAGE      79

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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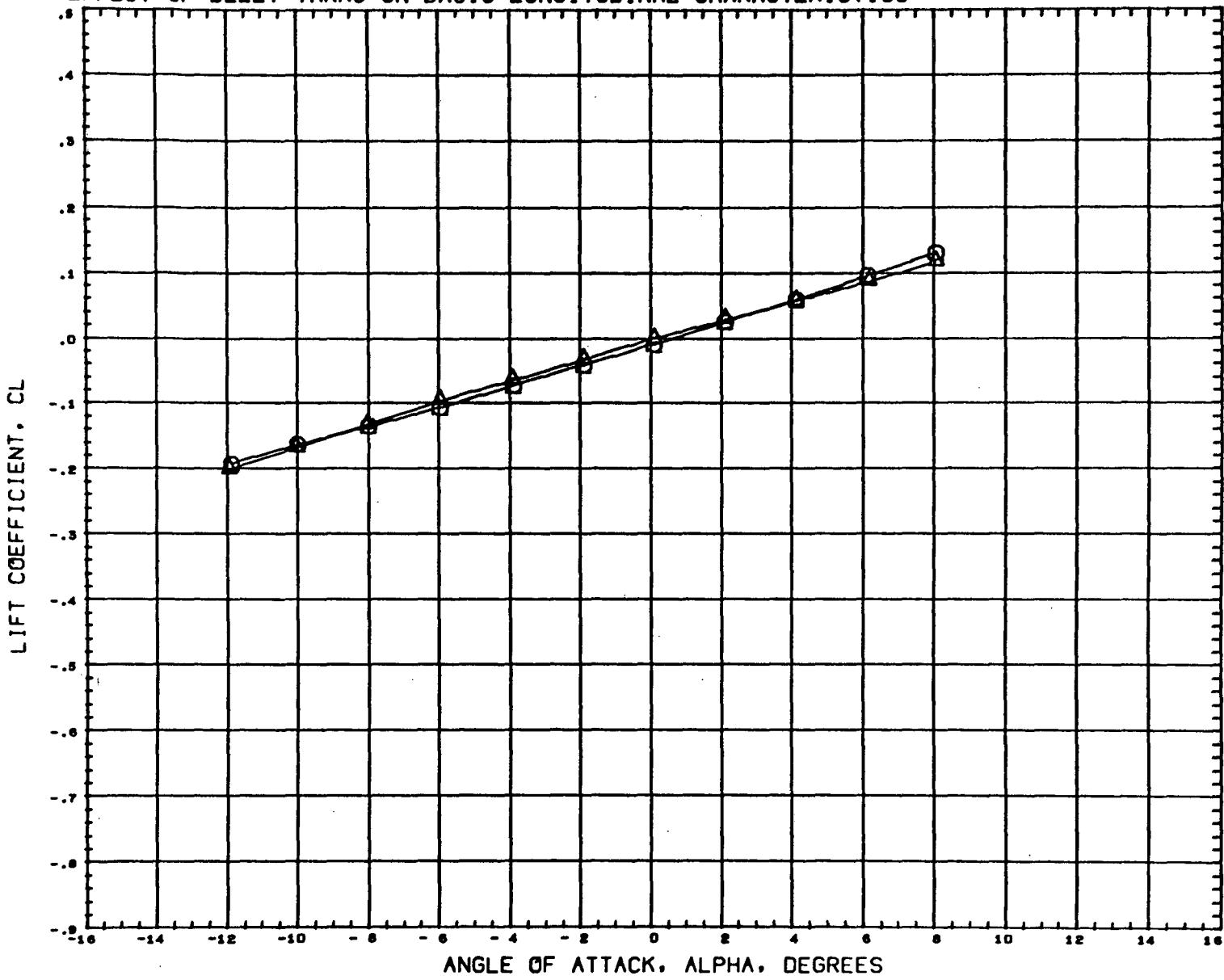
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MACH 8.000

PAGE 80

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



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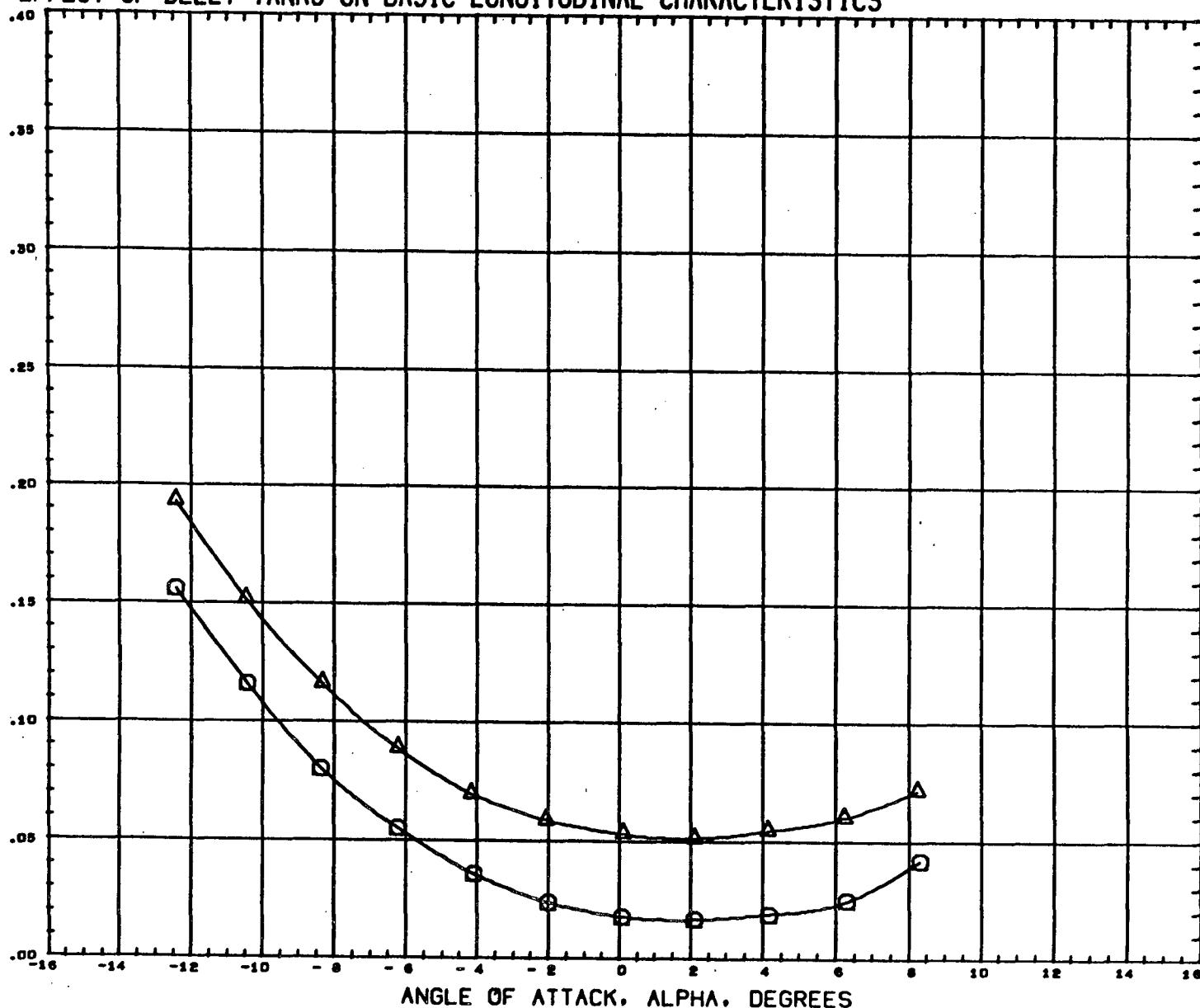
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MACH 4.959

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT. CDF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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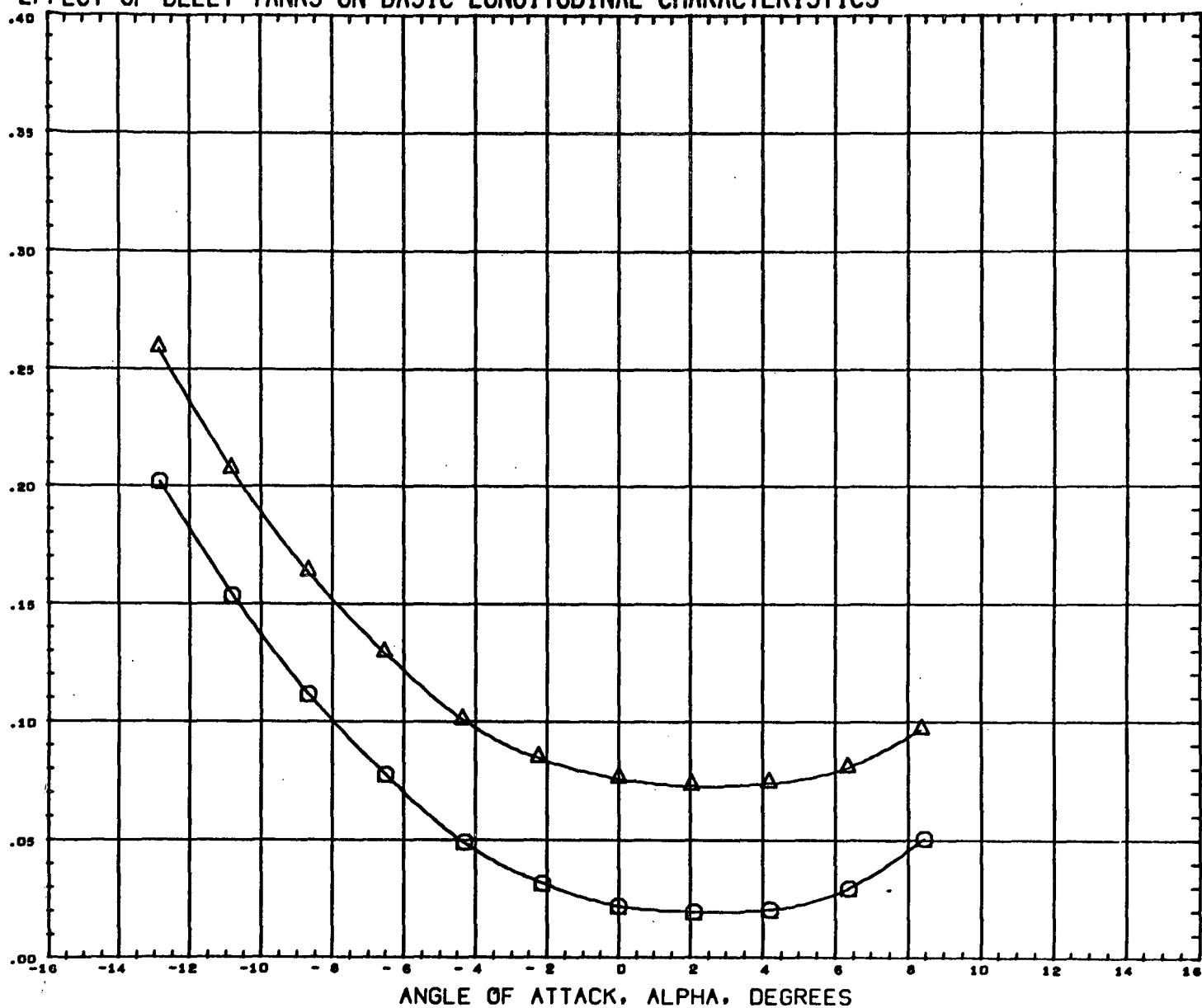
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 ZNRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.605

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## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, CDF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) MSFC5D9 NR 110C ORBITER B12W26E16V36  
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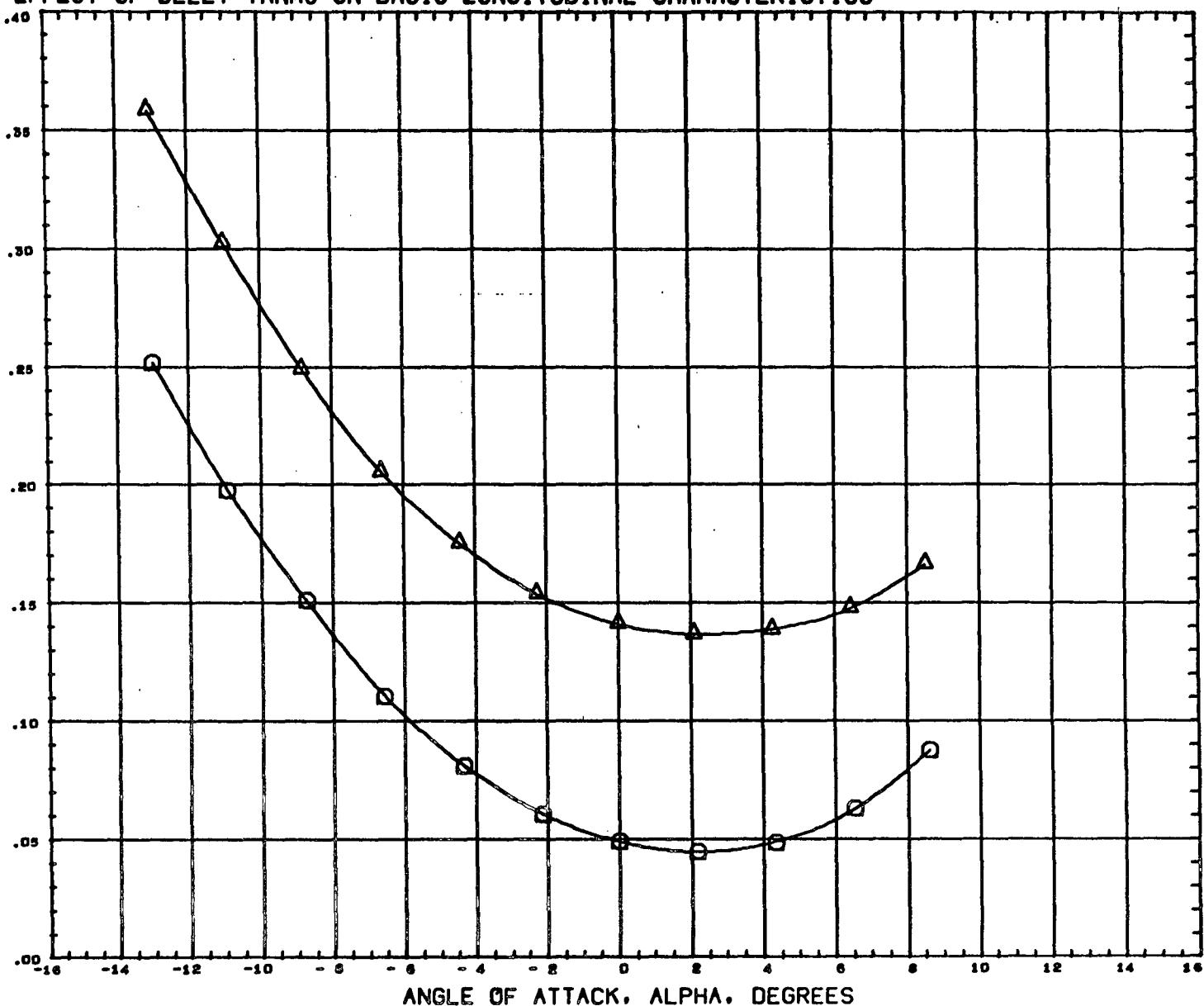
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MACH 0.898

PAGE 83

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT. CDF



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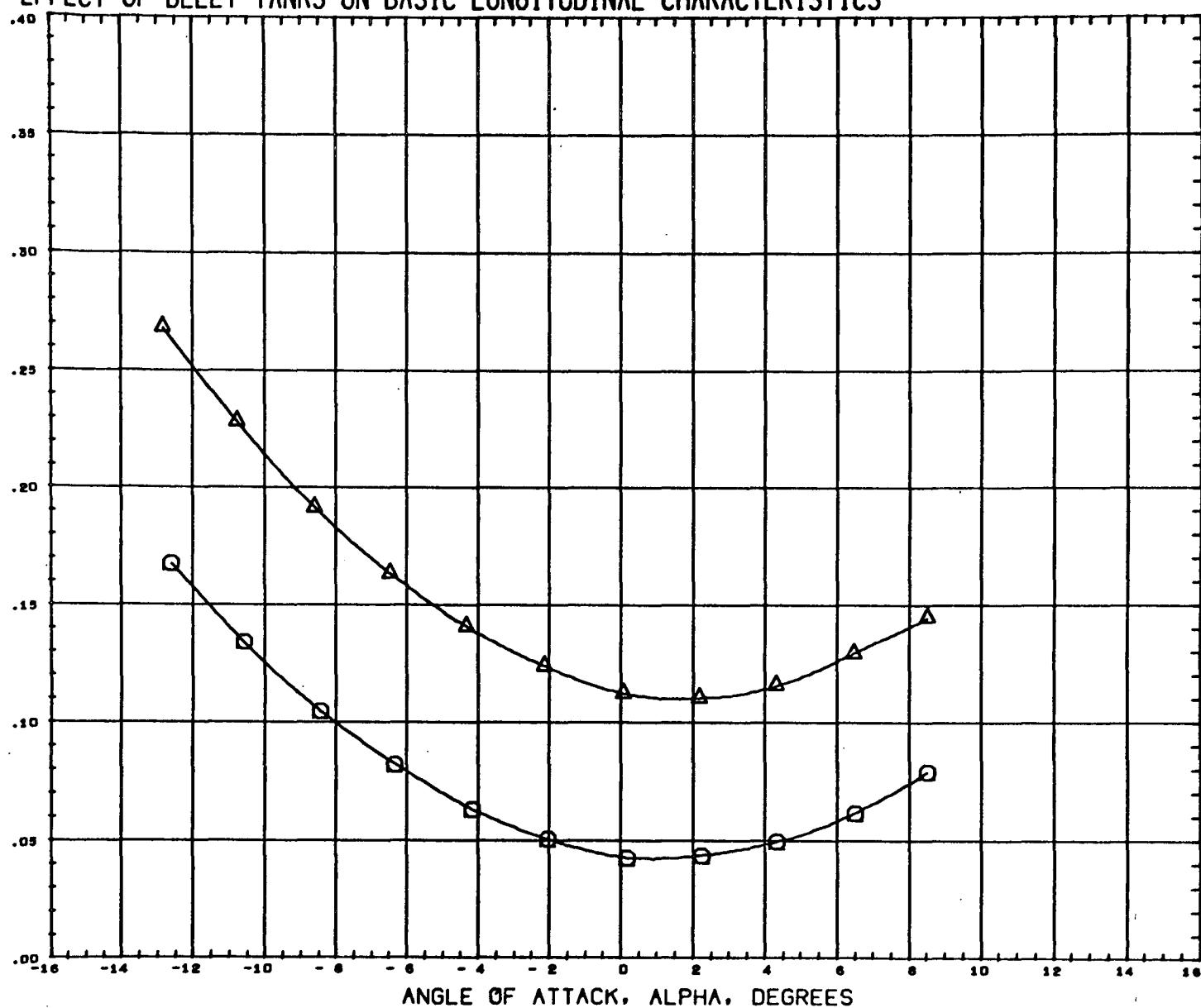
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MACH 8.194

PAGE 84

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, CDF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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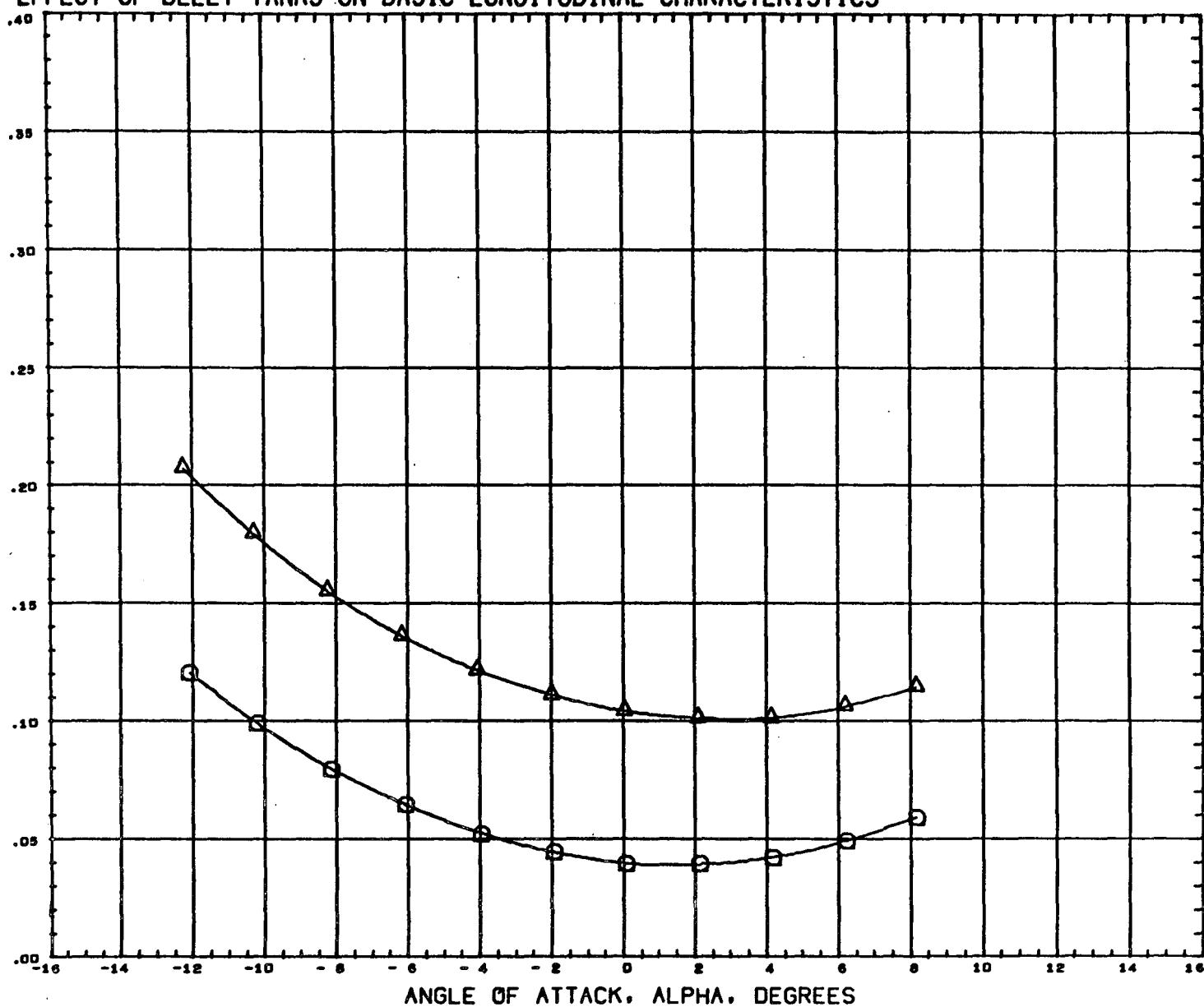
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.961

PAGE 85

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, CDF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) M8FC5D9 NR 11OC ORBITER B12W26E16V36  
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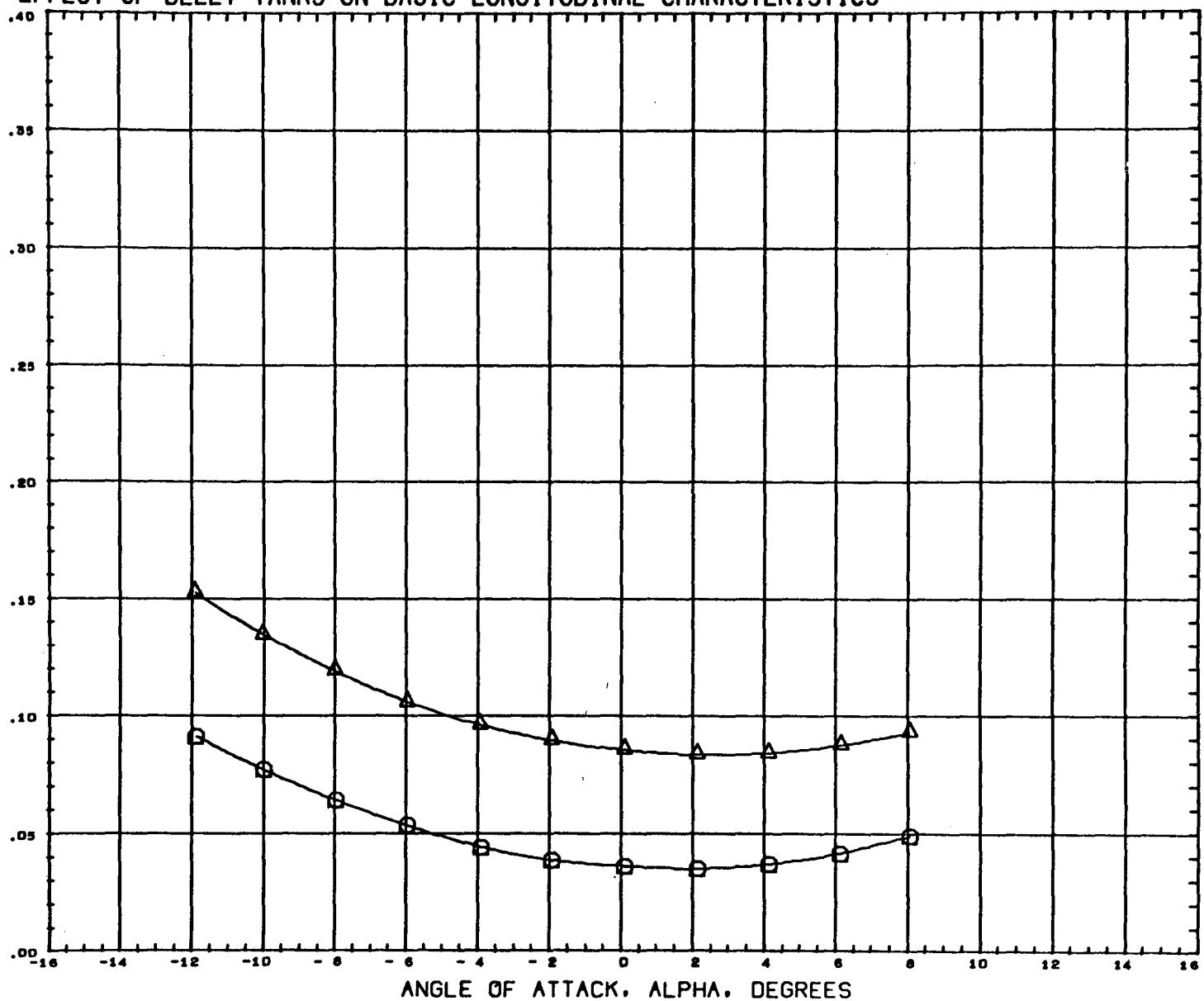
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 SCALE 0.0044 SCALE

MACH 2.990

PAGE 86

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

FOREBODY DRAG COEFFICIENT, COF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) MSFC509 NR 110C ORBITER B12W26E16V36  
 (J5107A) MSFC509 NR 110C ORBITER + TANK B12W26E16V36

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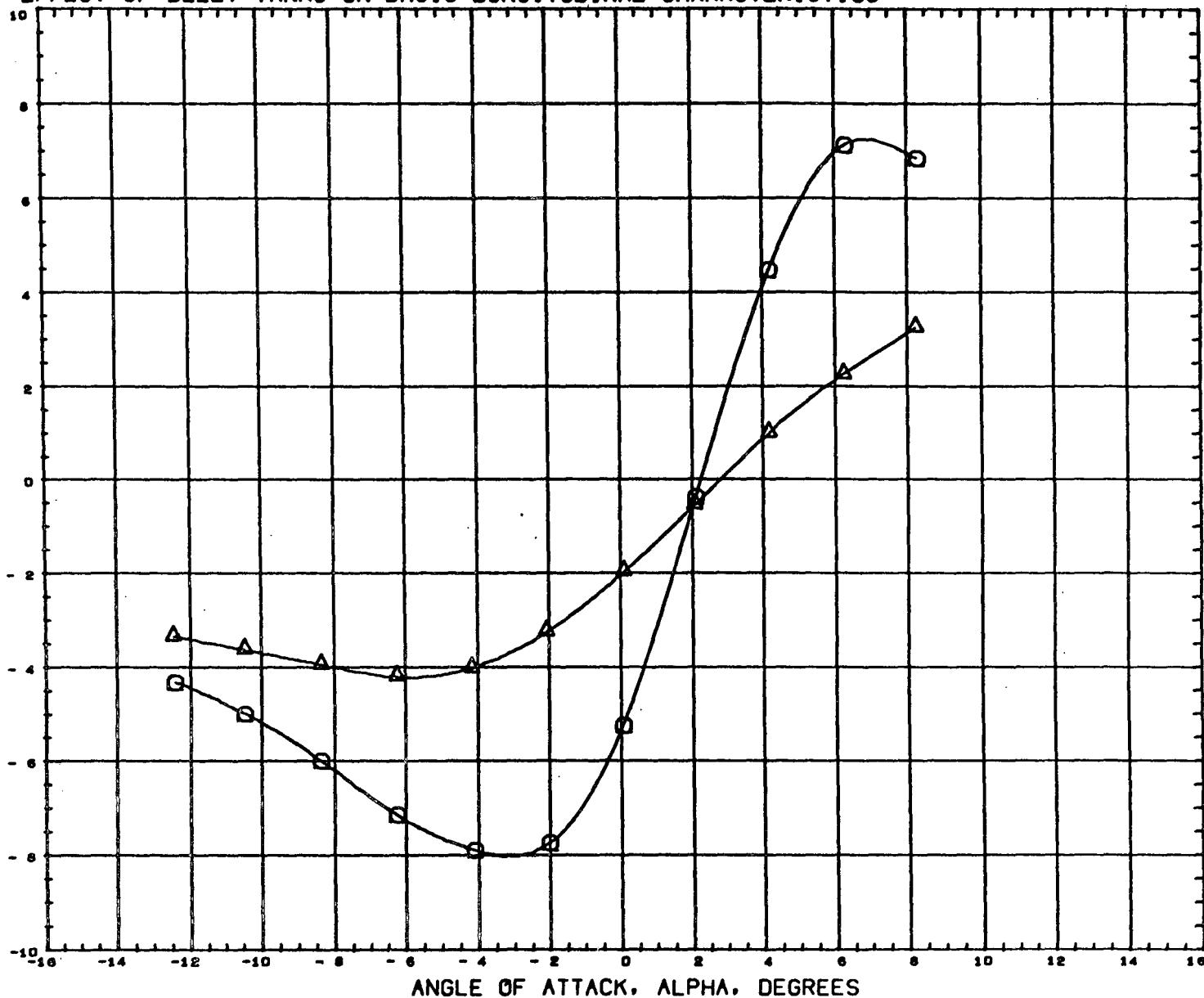
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 SCALE 0.0044 SCALE

MACH 4.959

PAGE 87

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO, L/D



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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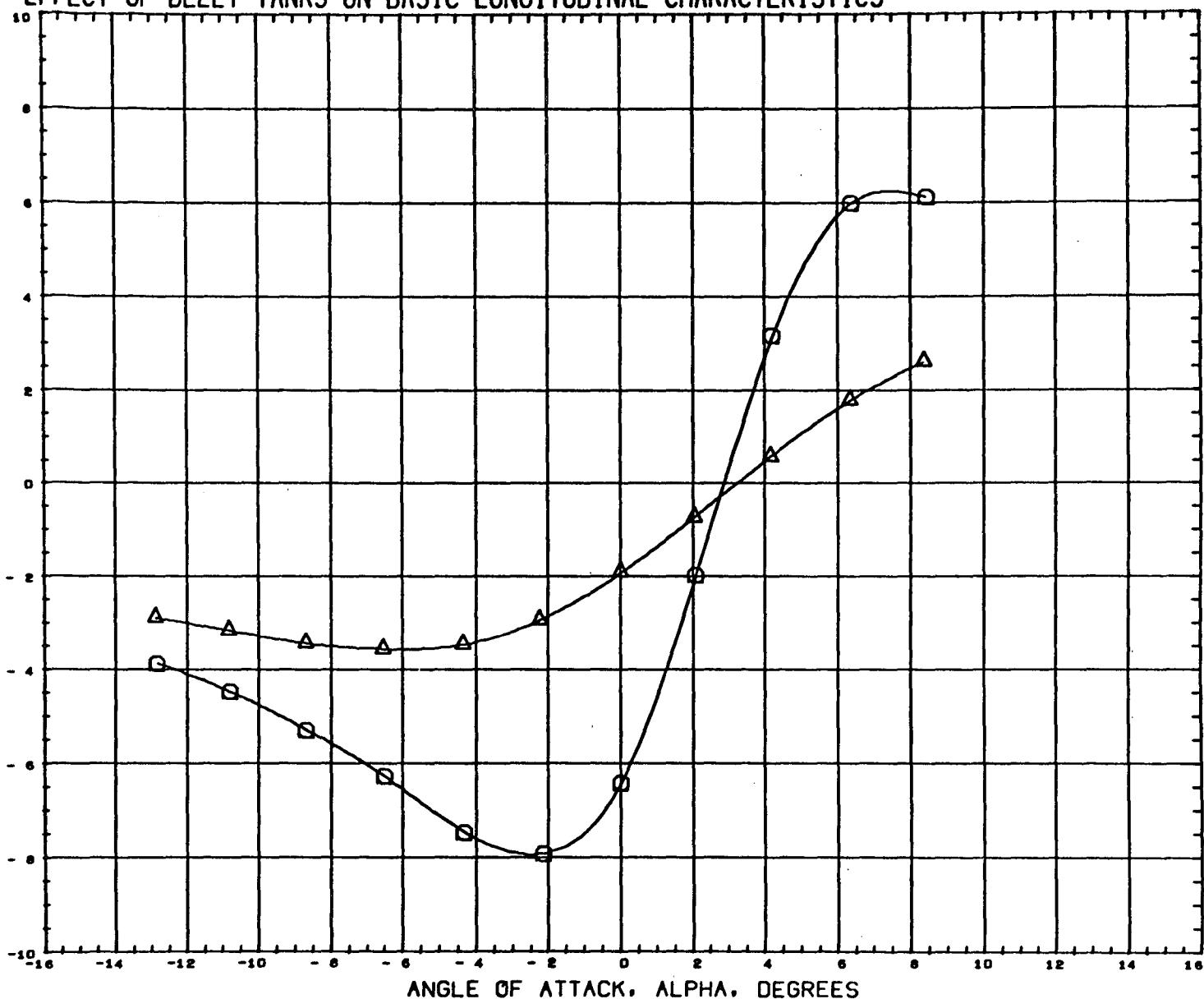
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 SCALE 0.0044 SCALE

MACH 0.605

PAGE 88

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO, L/DF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) Q M8FC509 NR 11OC ORBITER B12W26E16V36  
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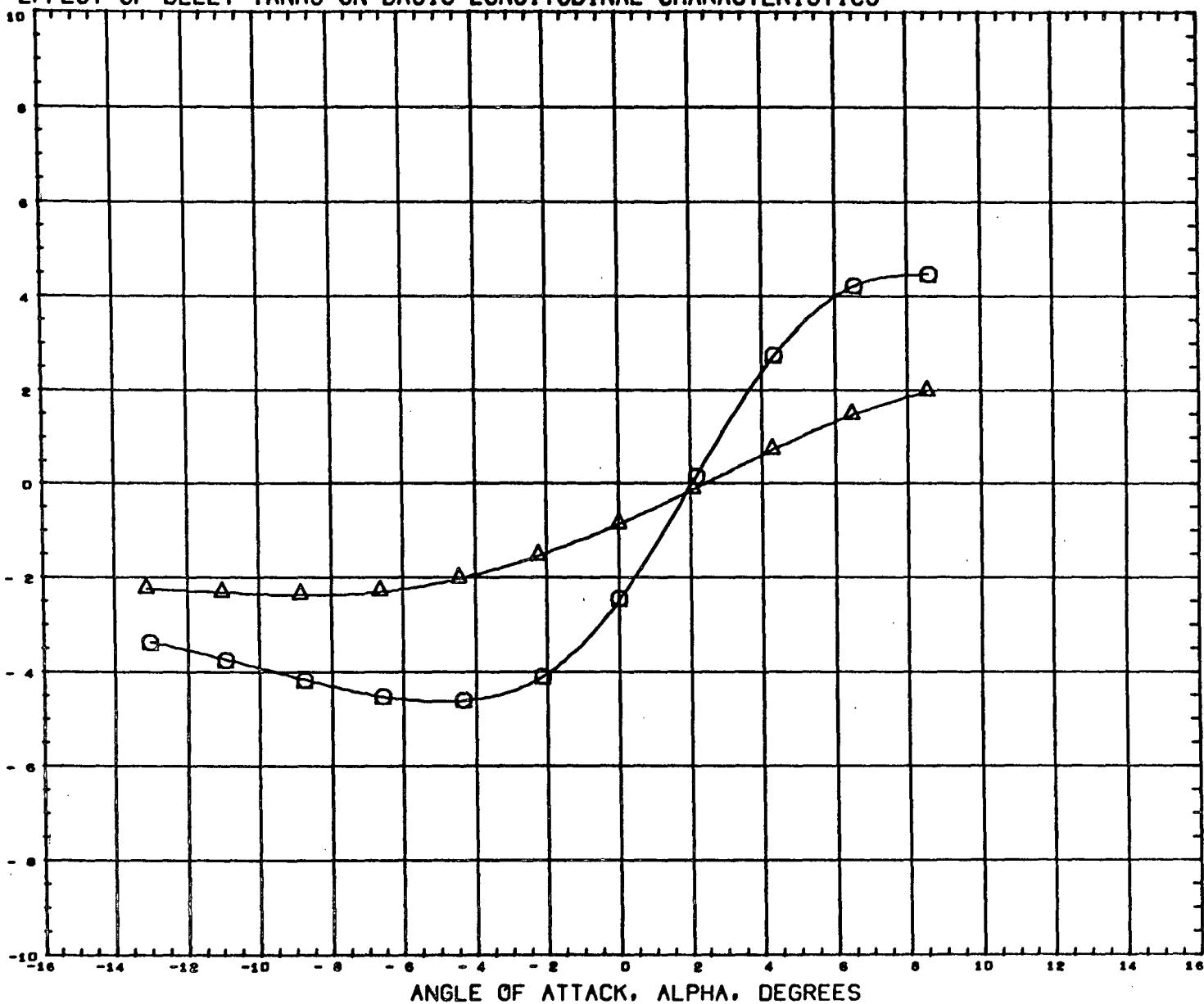
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 SCALE 0.0044 SCALE

MACH 0.898

PAGE 89

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO, L/DF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J51D1A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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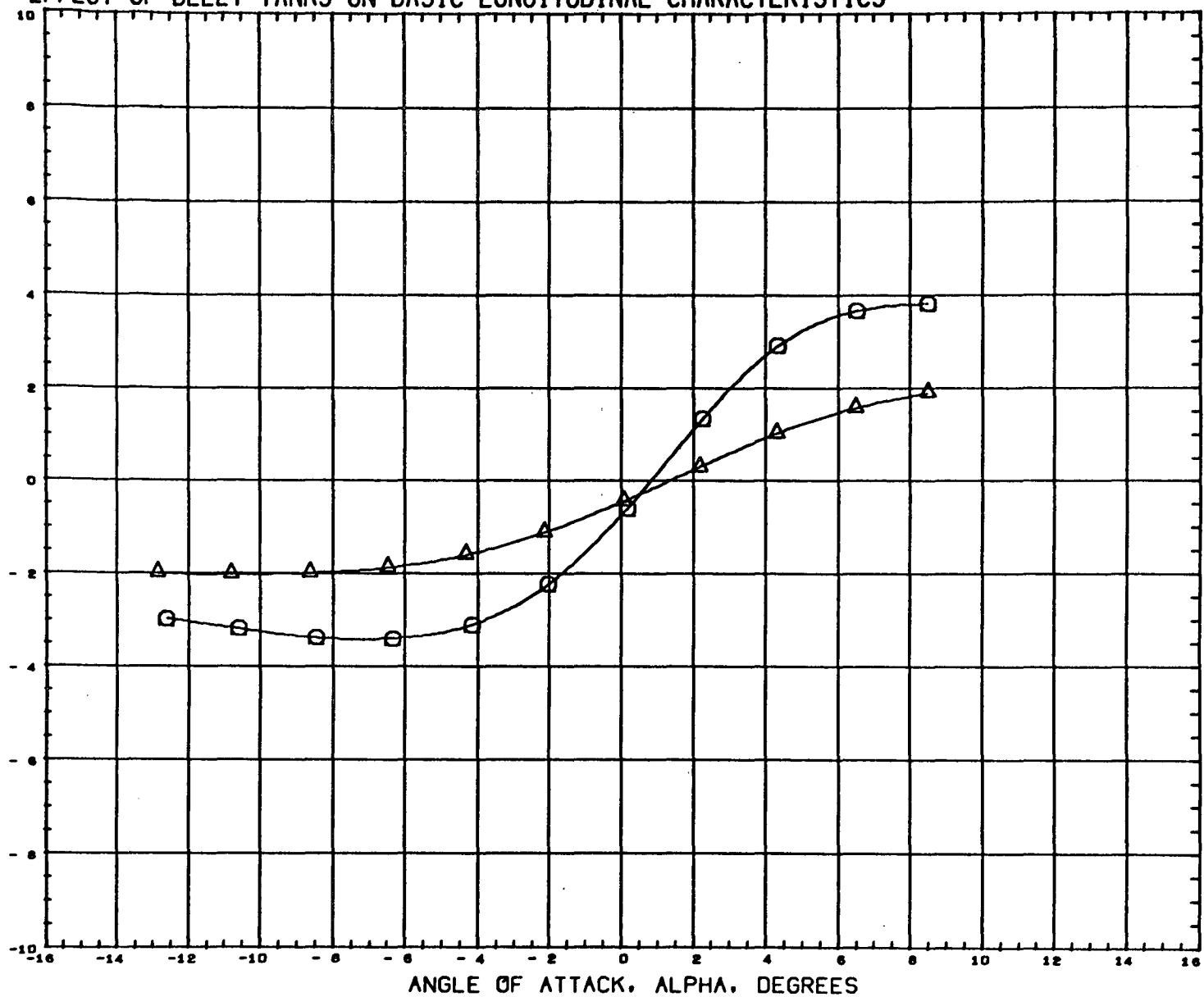
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 SCALE 0.0044 SCALE

MACH 8.194

PAGE 90

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO. L/DF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) M8FC5D9 NR 11OC ORBITER B12W26E16V36  
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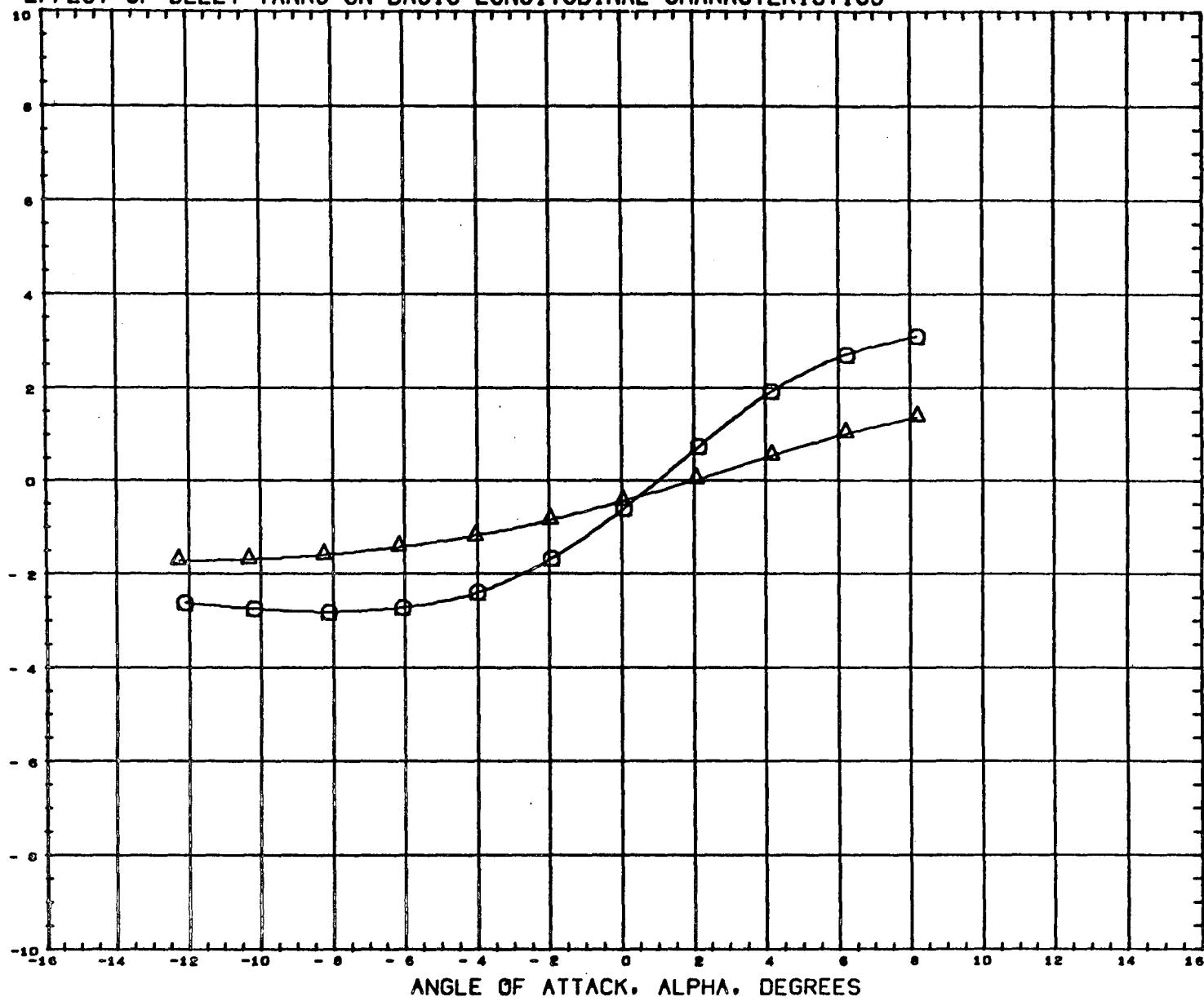
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.961

PAGE 91

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO. L/D<sub>0</sub>



DATA SET SYMBOL: CONFIGURATION DESCRIPTION  
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 (JS107A) D M8FC509 NR 11OC ORBITER + TANK B12W26E16V36

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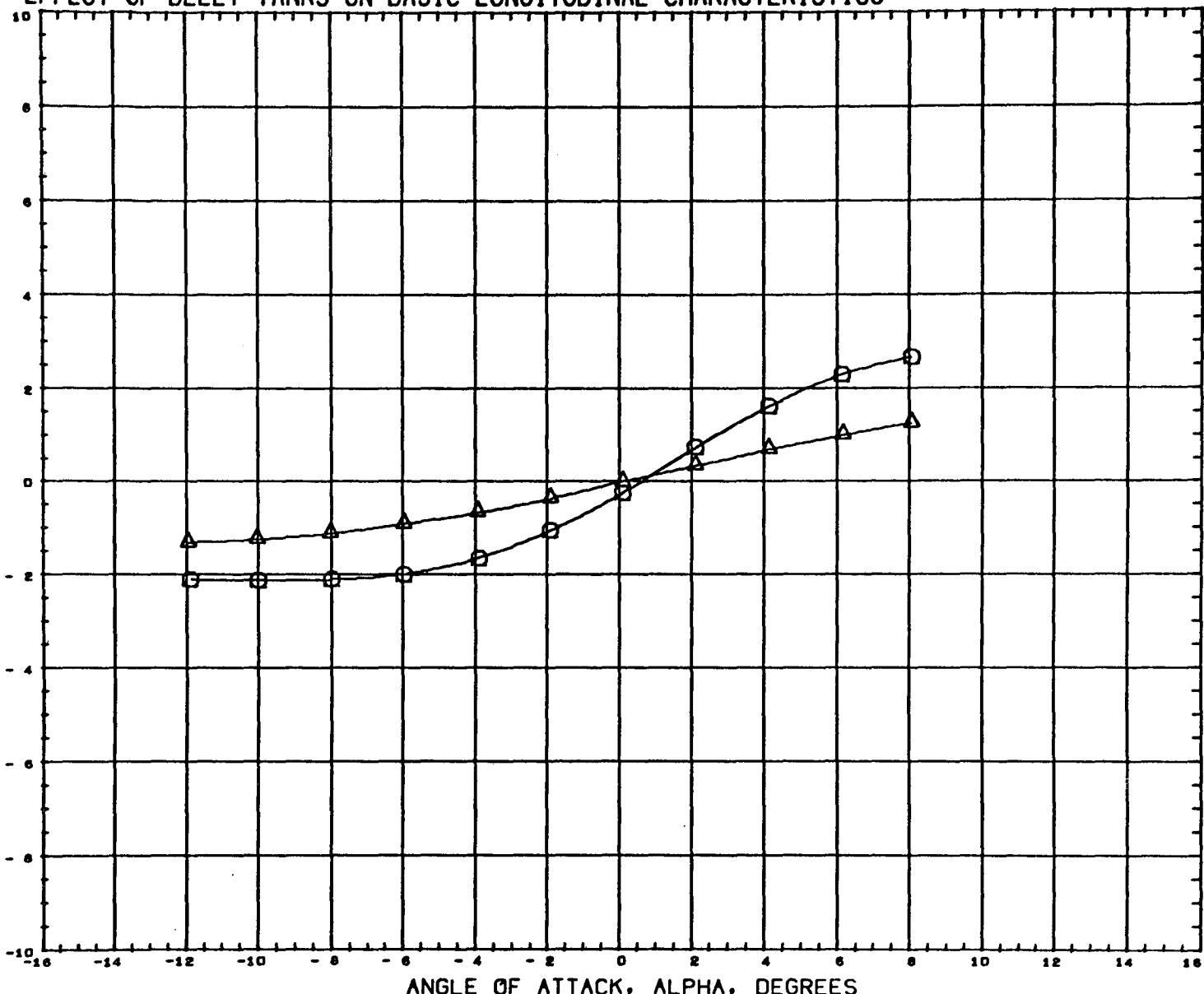
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 ZMRP - 0.0990 INCHES  
 BSCALE 0.0044 SCALE

MACH 2.990

PAGE 92

## EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LIFT-FOREBODY DRAG RATIO, L/DF



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (J5101A) MSFC509 NR 110C ORBITER B12W26E16V36  
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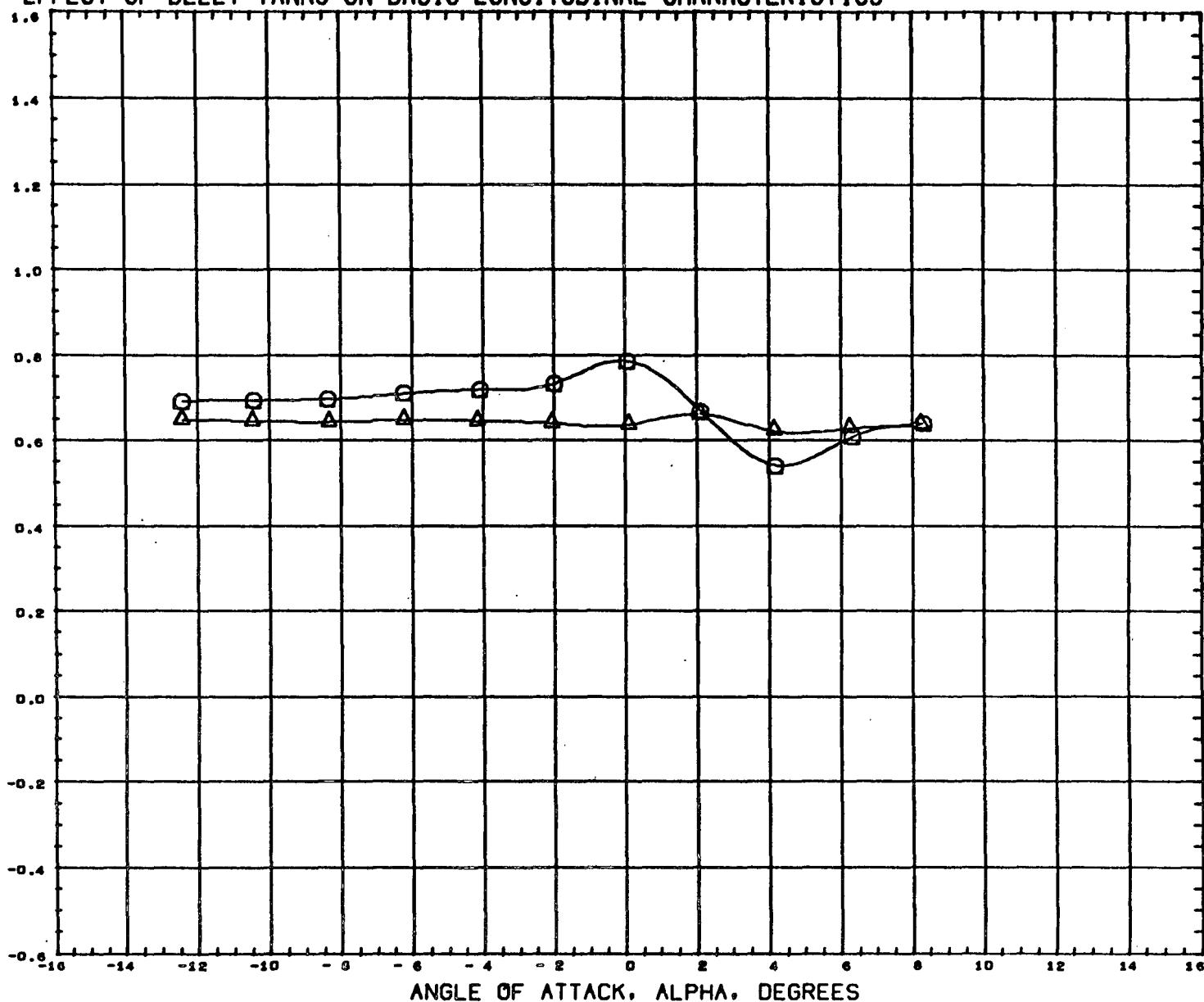
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 SCALE 0.0044 SCALE

MACH 4.959

PAGE 93

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE, XCP/L. PERCENT BODY LENGTH



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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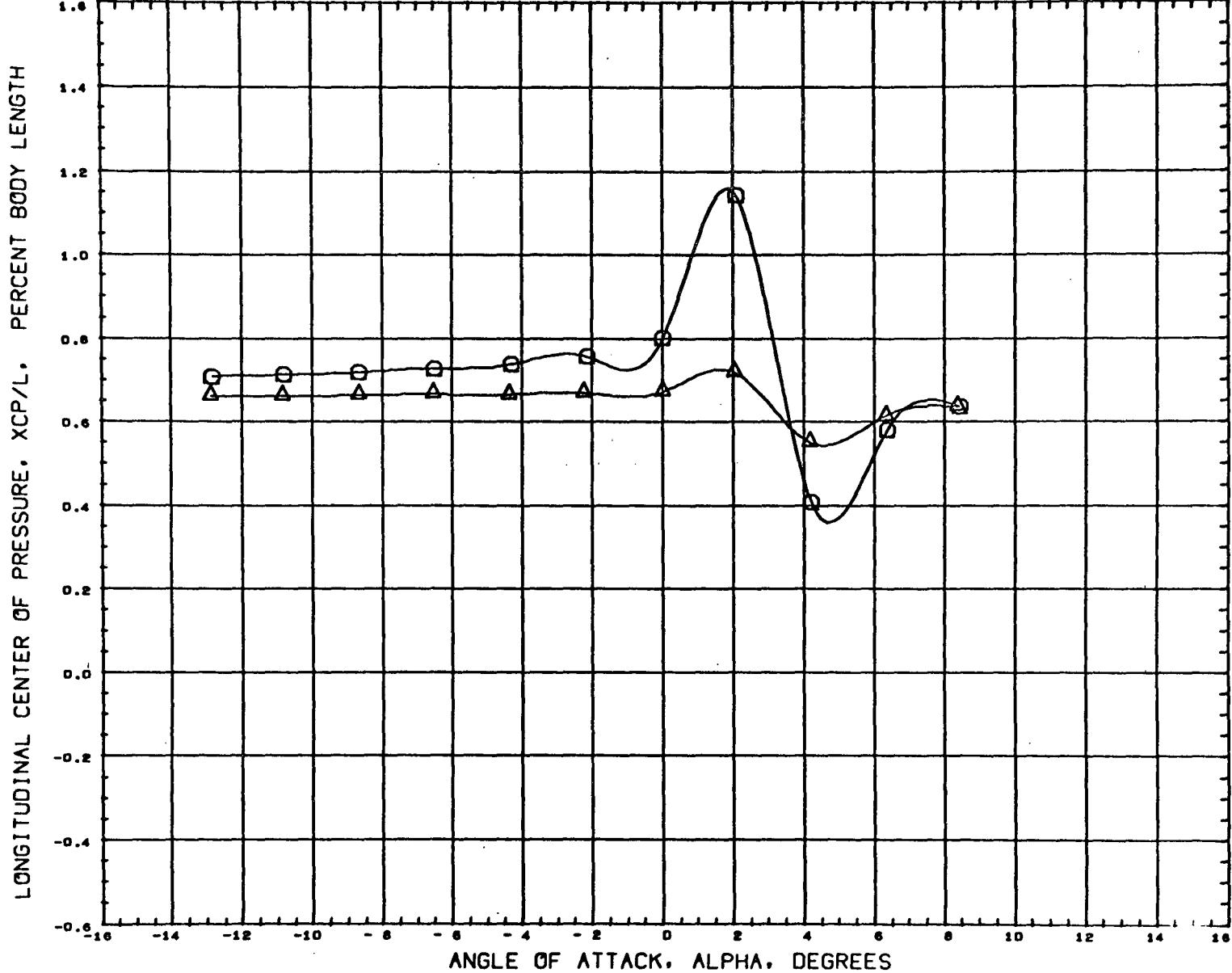
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 SCALE 0.0044 SCALE

MACH 0.605

PAGE 94

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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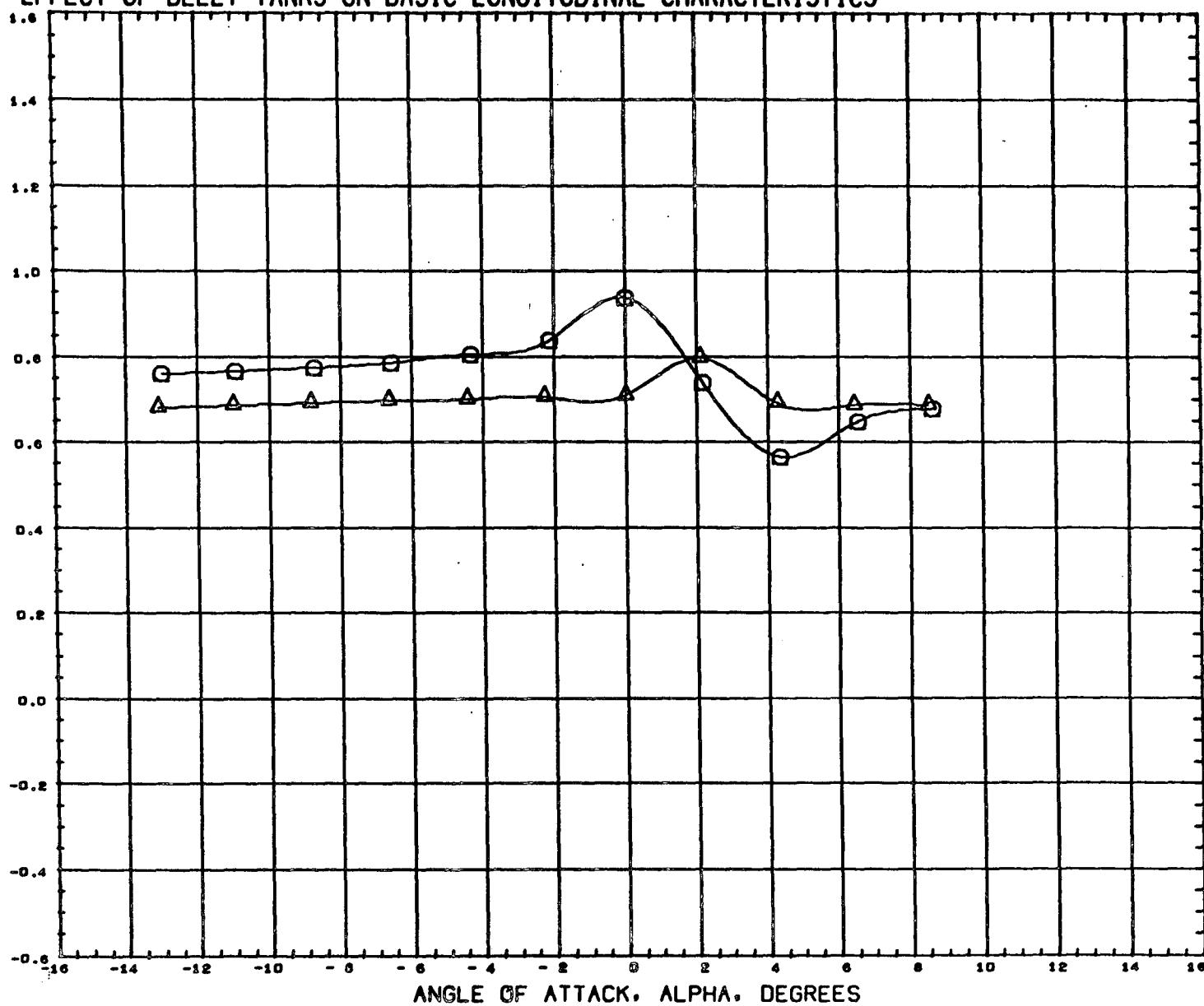
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MACH 0.898

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE, XCP/L. PERCENT BODY LENGTH



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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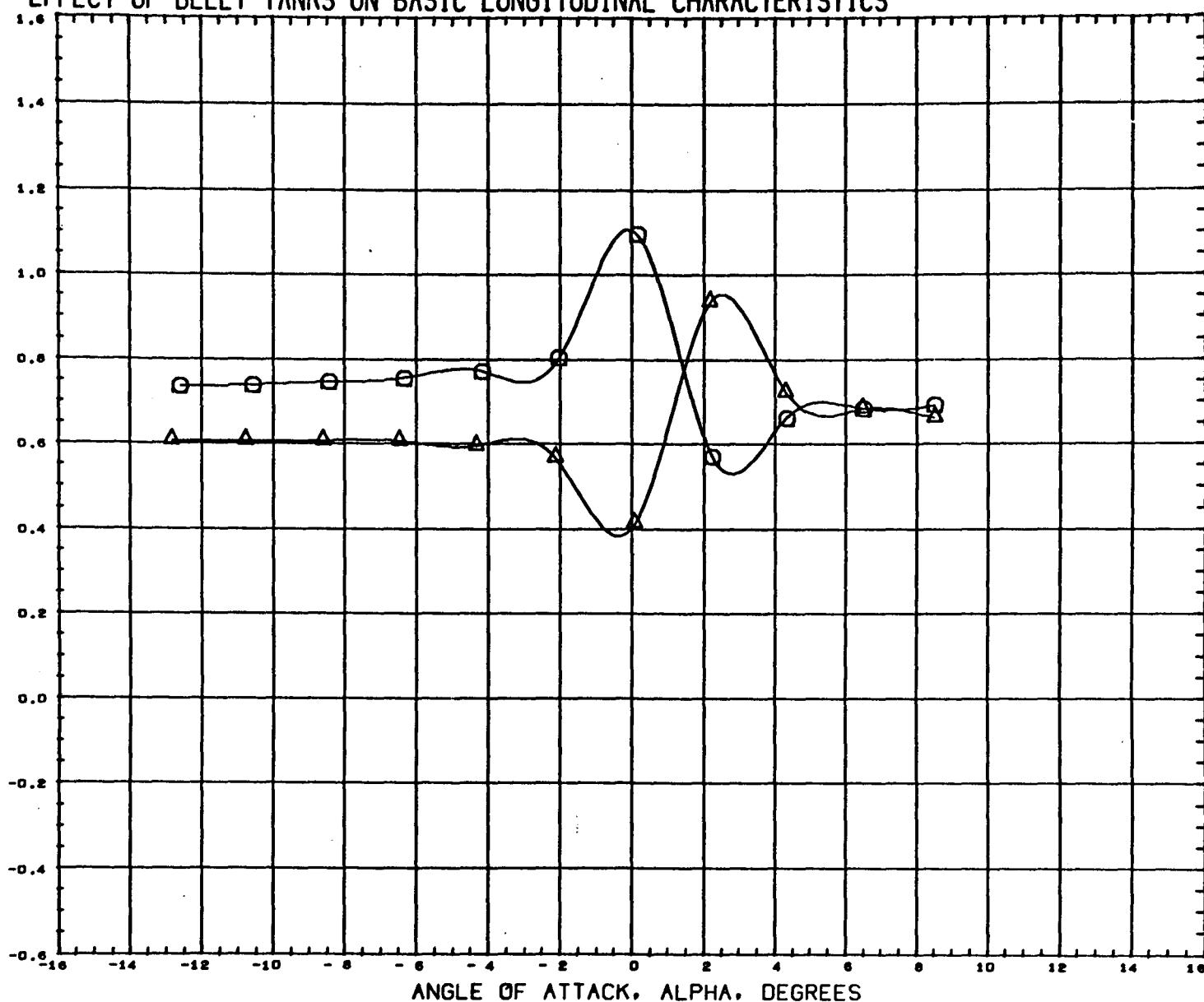
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 SCALE 0.0044 SCALE

MACH 1.194

PAGE 96

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE, XCP/L. PERCENT BODY LENGTH



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(J5101A) MSFC509 NR 110C ORBITER B12W26E16V36  
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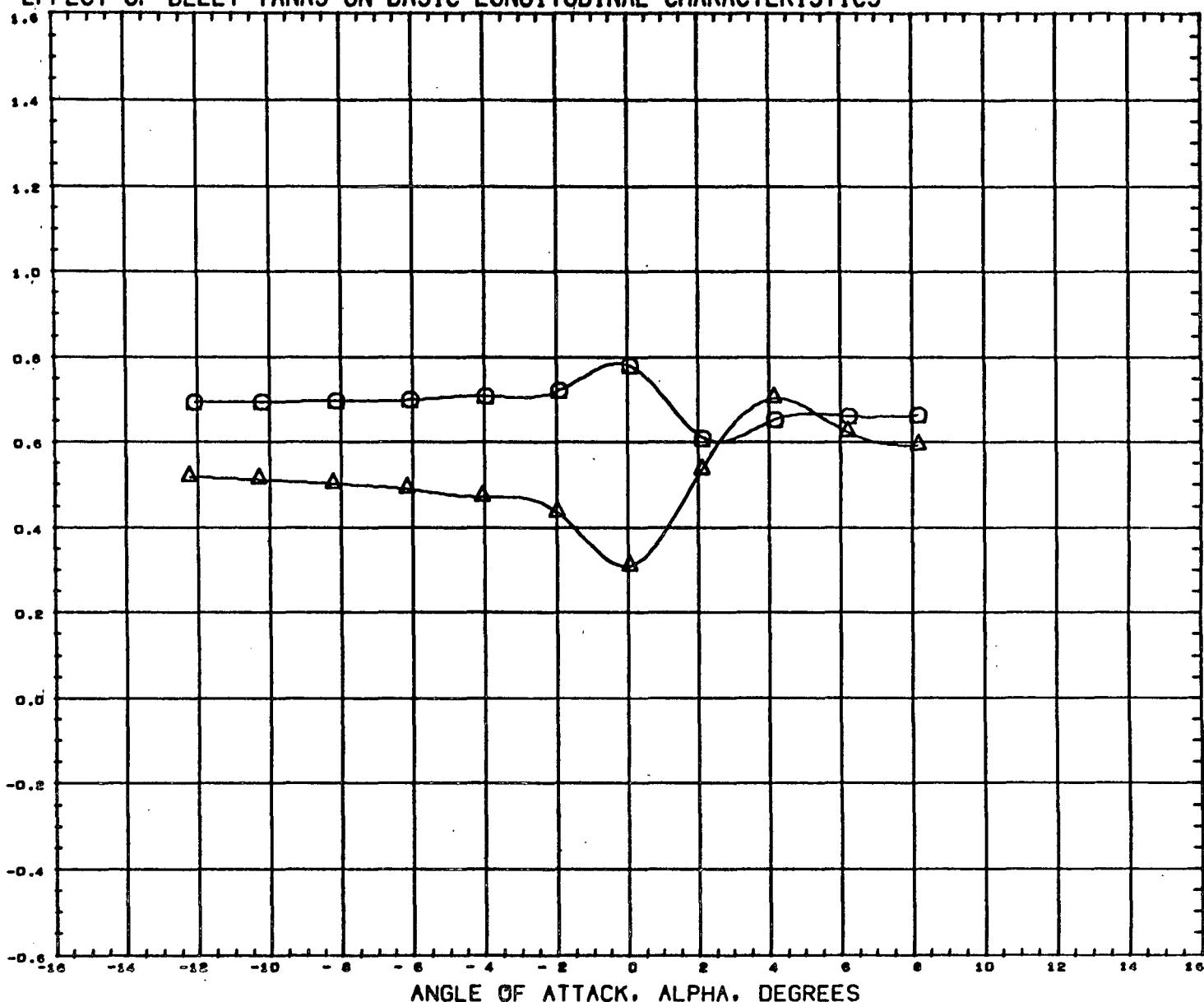
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SCALE	0.0044	SCALE

MACH 1.961

PAGE 97

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE, XCP/L. PERCENT BODY LENGTH



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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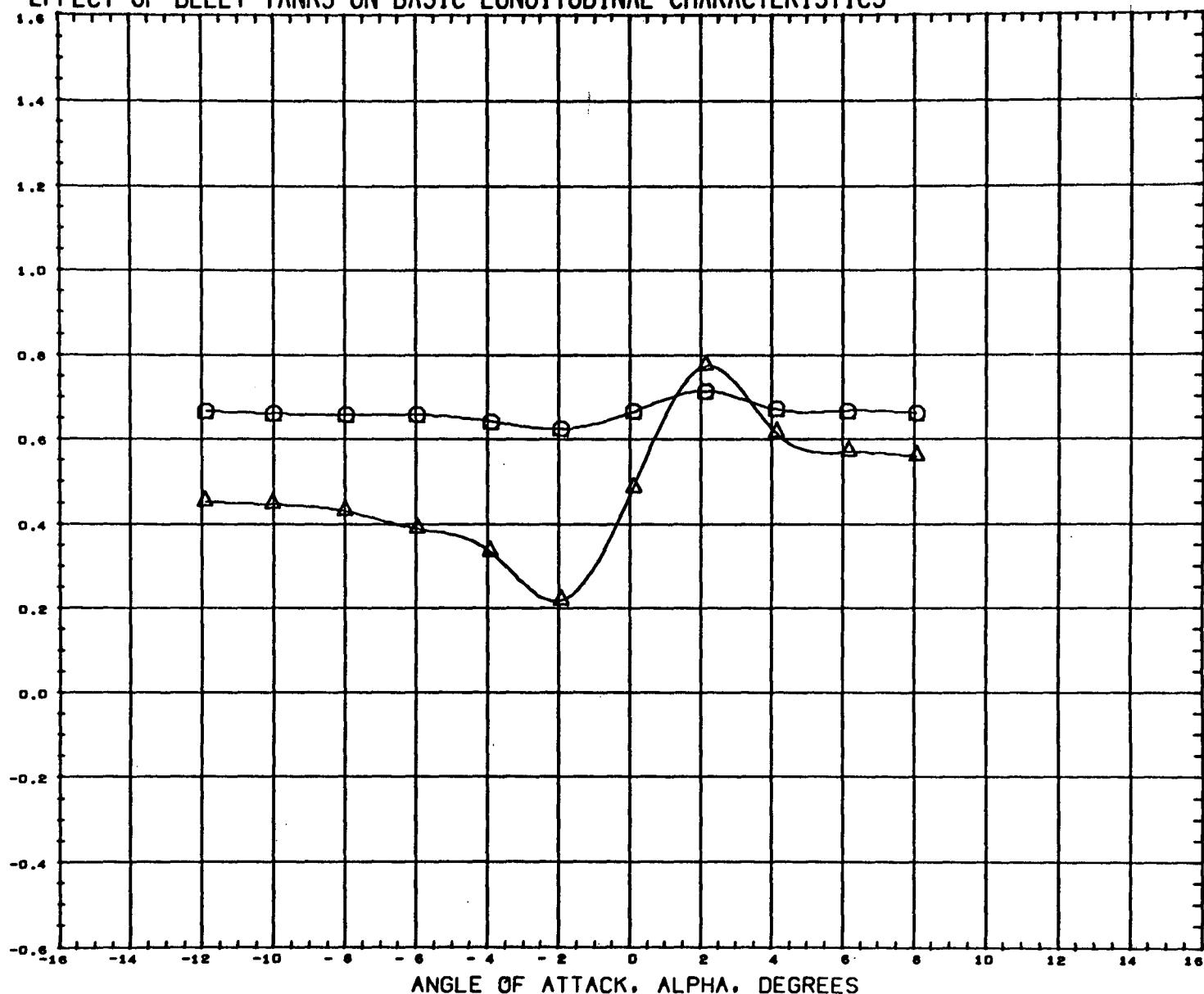
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 SCALE 0.0044 SCALE

MACH 2.090

PAGE 98

# EFFECT OF BELLY TANKS ON BASIC LONGITUDINAL CHARACTERISTICS

LONGITUDINAL CENTER OF PRESSURE. XCP/L. PERCENT BODY LENGTH



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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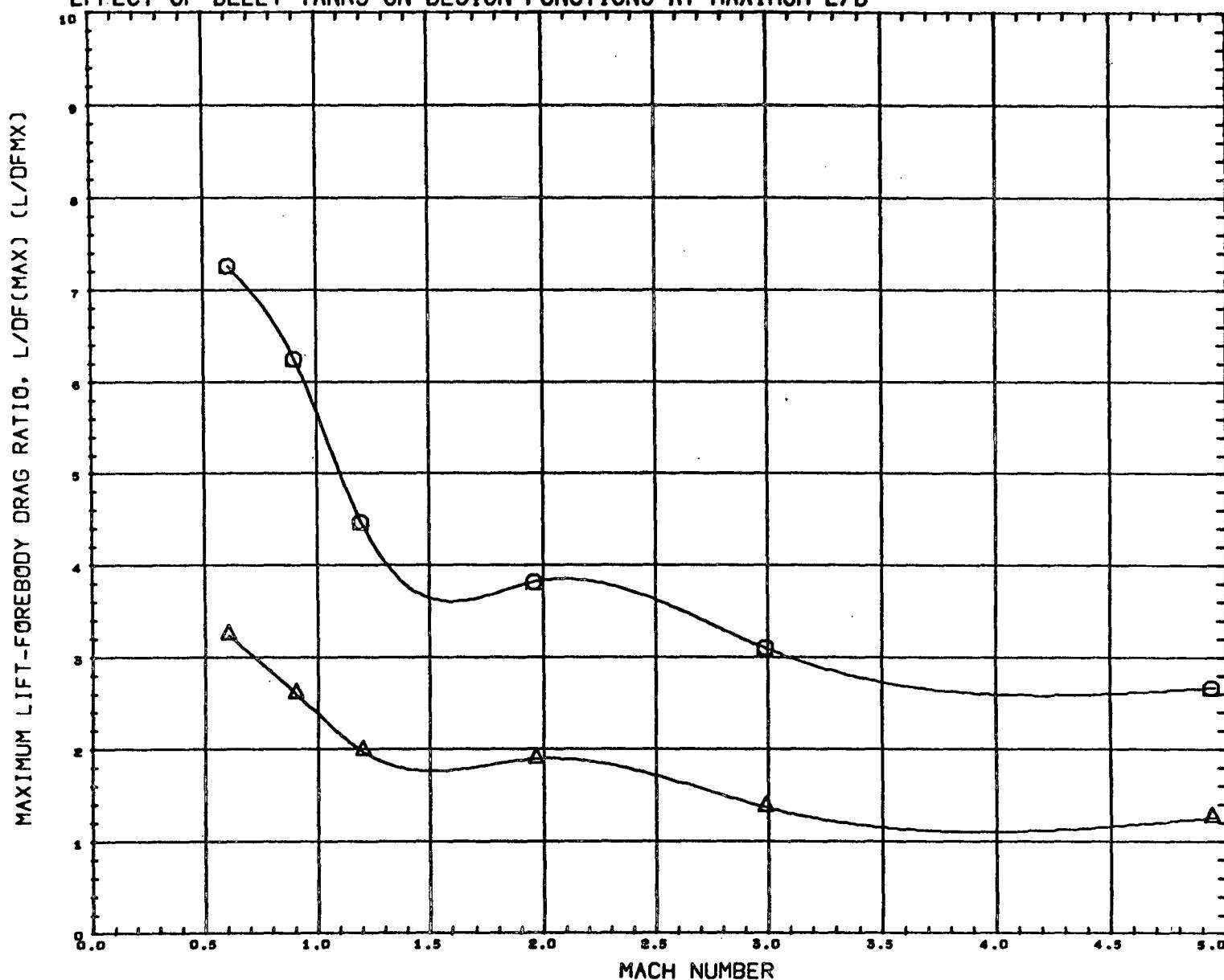
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MACH 4.959

PAGE 99

# EFFECT OF BELLY TANKS ON DESIGN FUNCTIONS AT MAXIMUM L/D

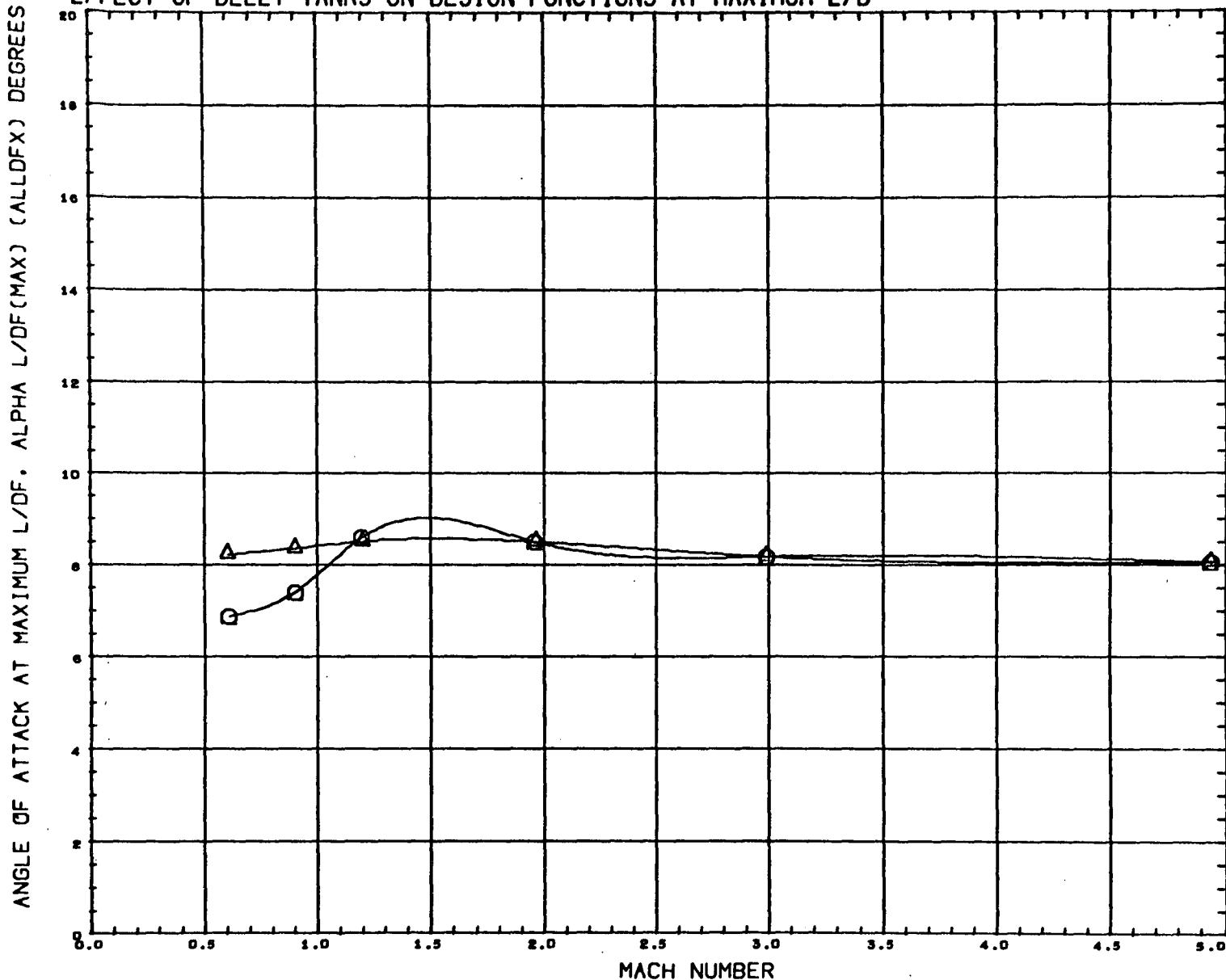


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# EFFECT OF BELLY TANKS ON DESIGN FUNCTIONS AT MAXIMUM L/D



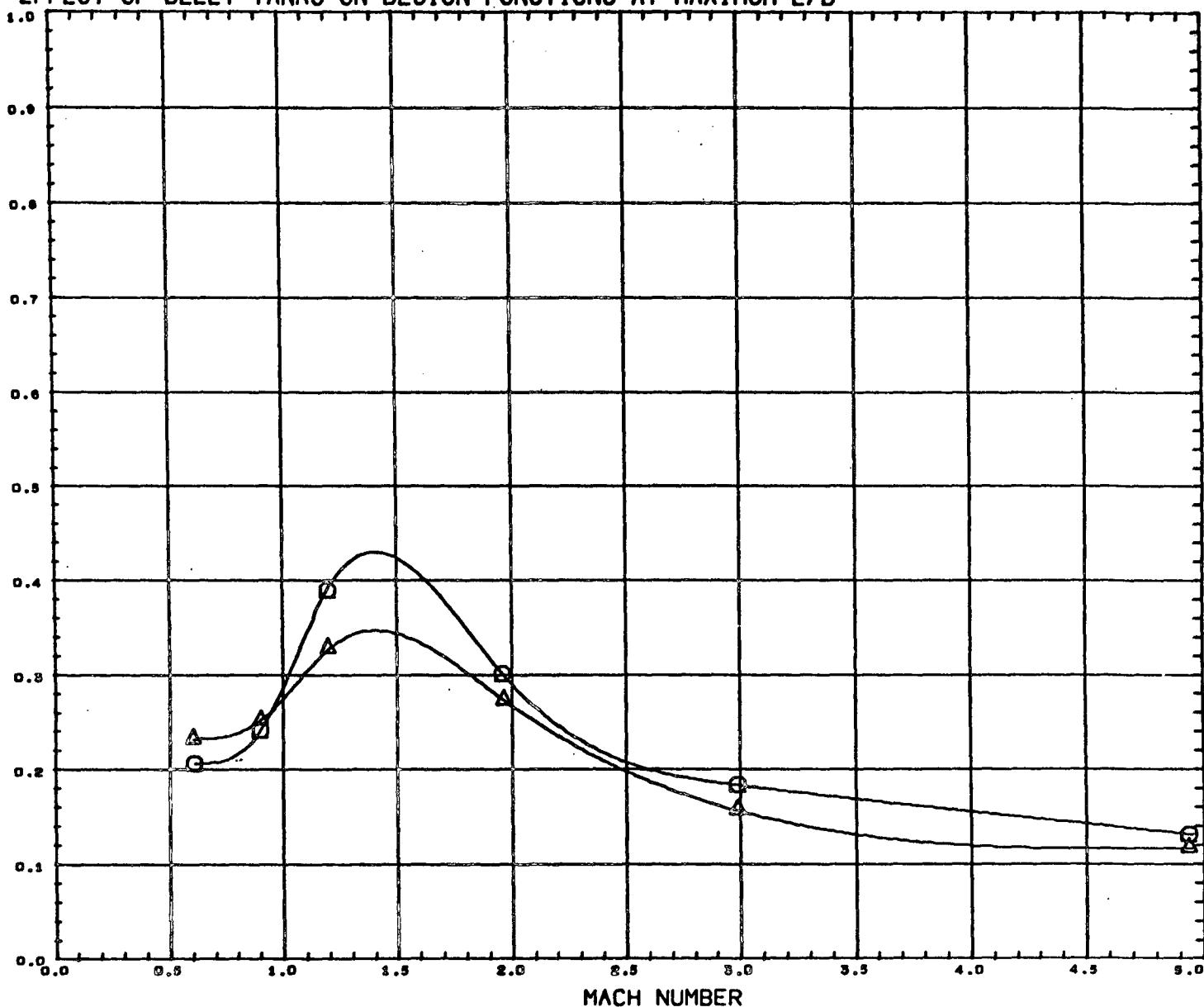
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REFERENCE INFORMATION  
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 BSCALE 0.0044 SCALE

# EFFECT OF BELLY TANKS ON DESIGN FUNCTIONS AT MAXIMUM L/D

LIFT COEFFICIENT AT MAXIMUM L/D F. CL L/D F(MAX) (CLLD/FX)



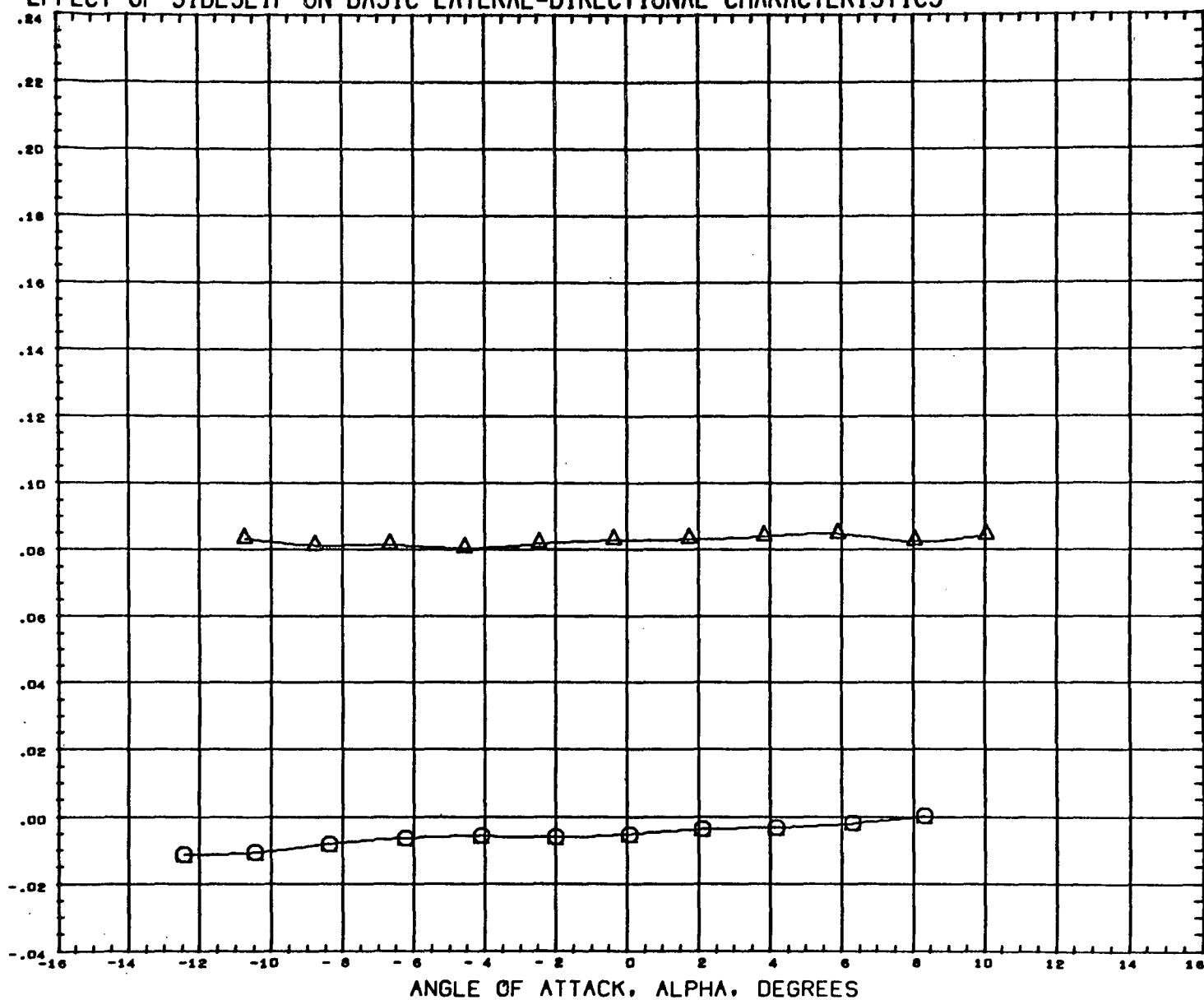
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BETA  
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REFERENCE INFORMATION  
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# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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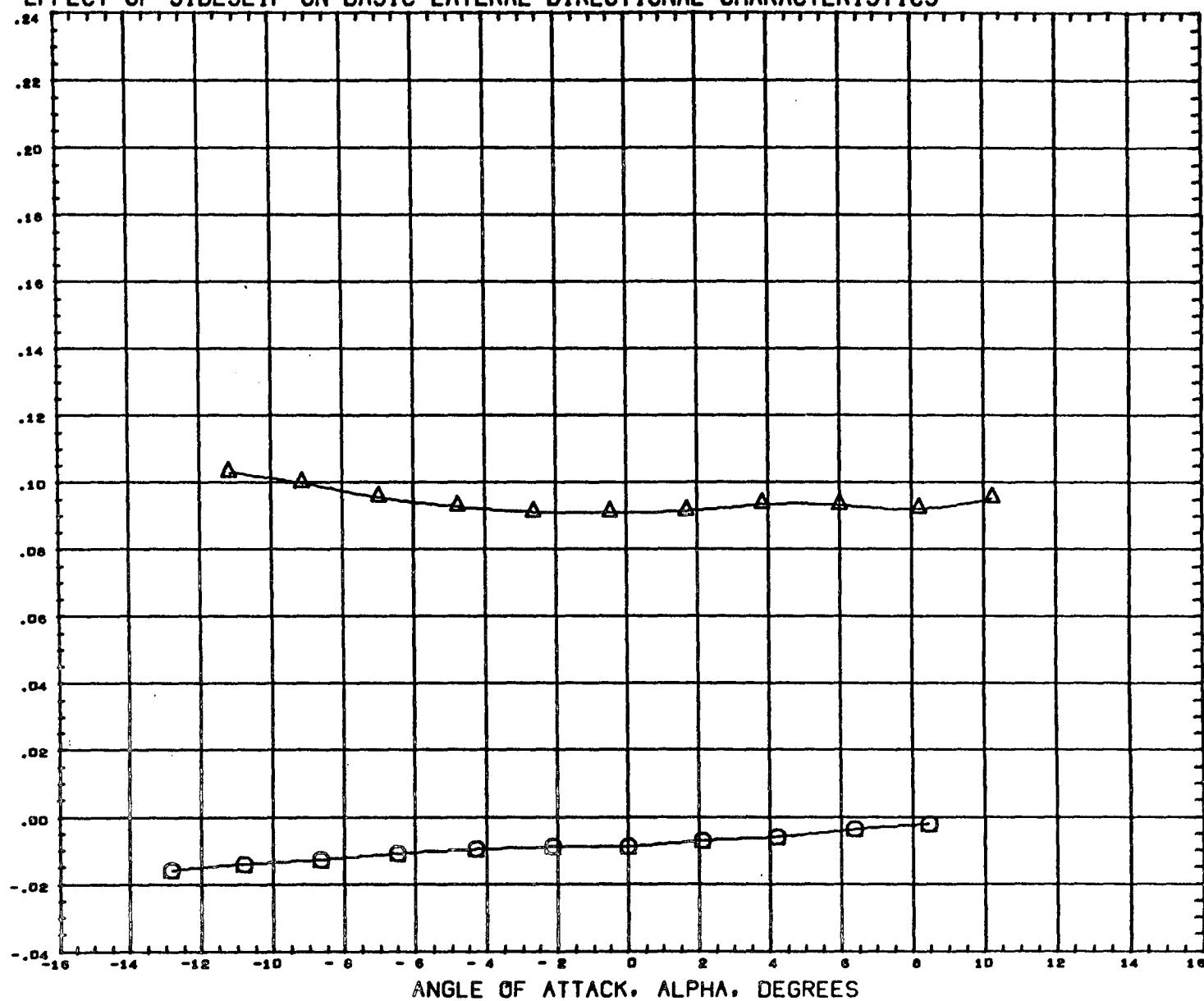
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 SCALE 0.0044 SCALE

MACH 0.605

PAGE 103

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) Q MSFC509 NR 11OC ORBITER B12W26E16V36  
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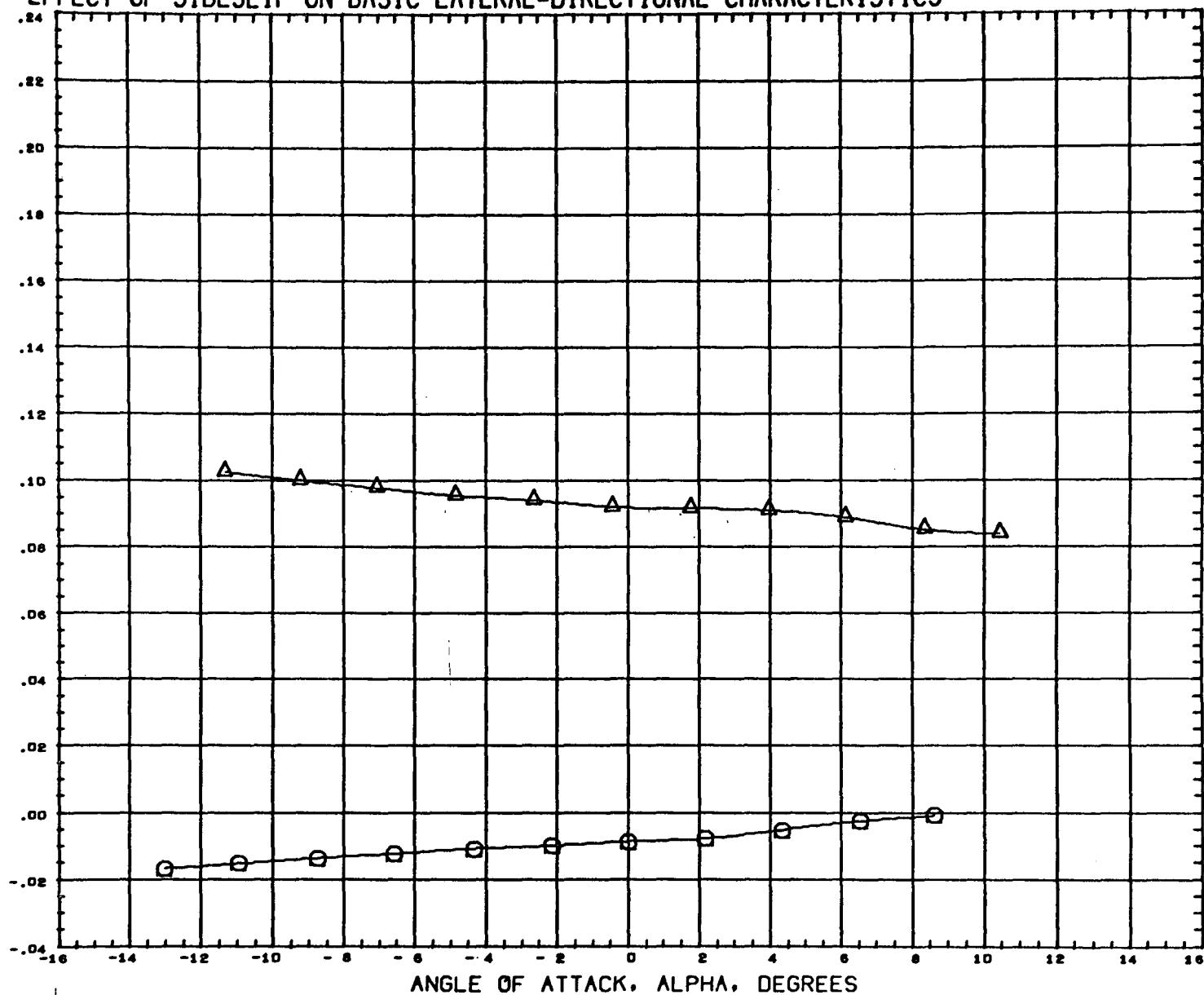
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MACH 0.698

PAGE 104

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) Q MSFC509 NR 11OC ORBITER B12W26E16V36  
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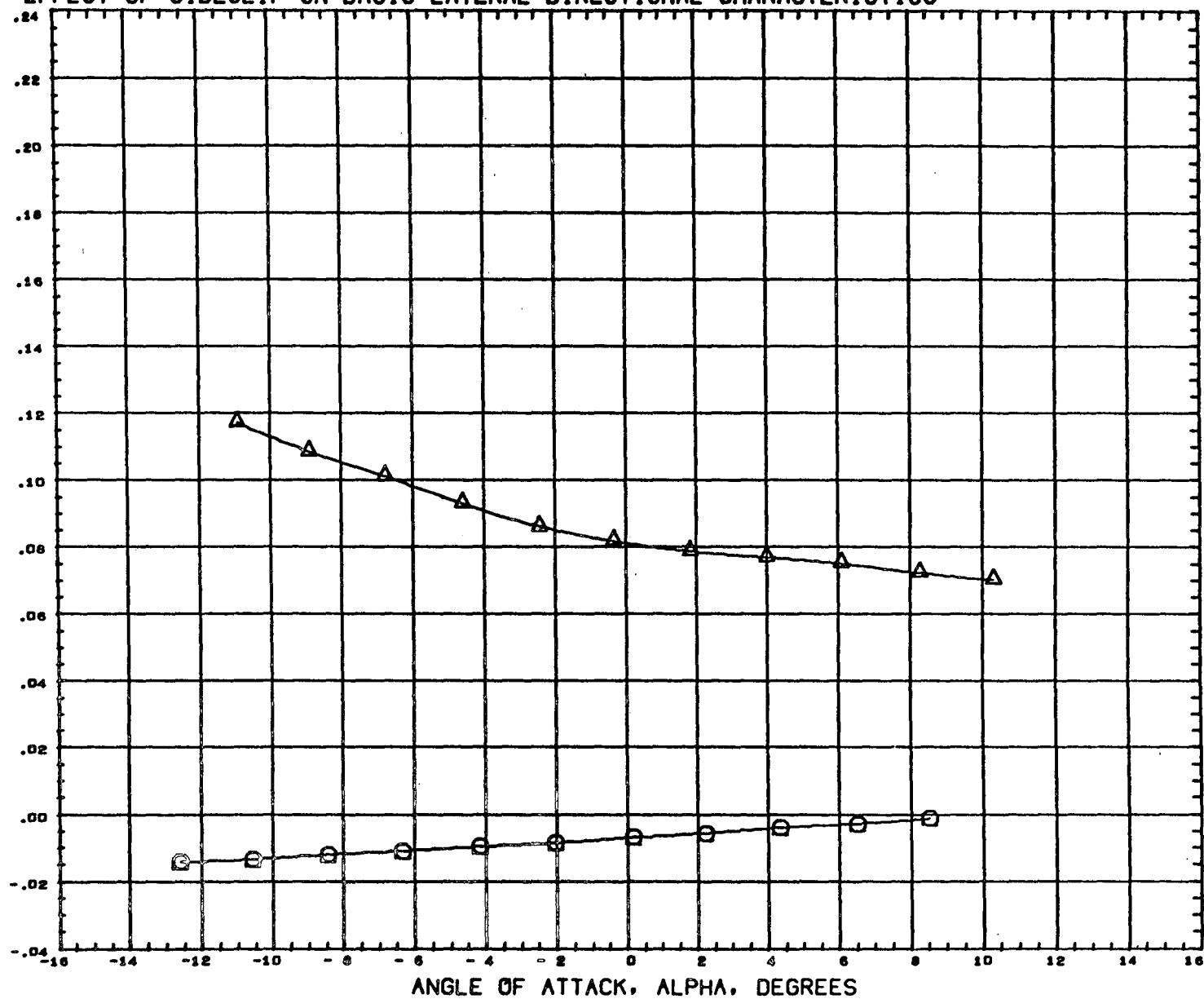
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MACH 1.194

PAGE 105

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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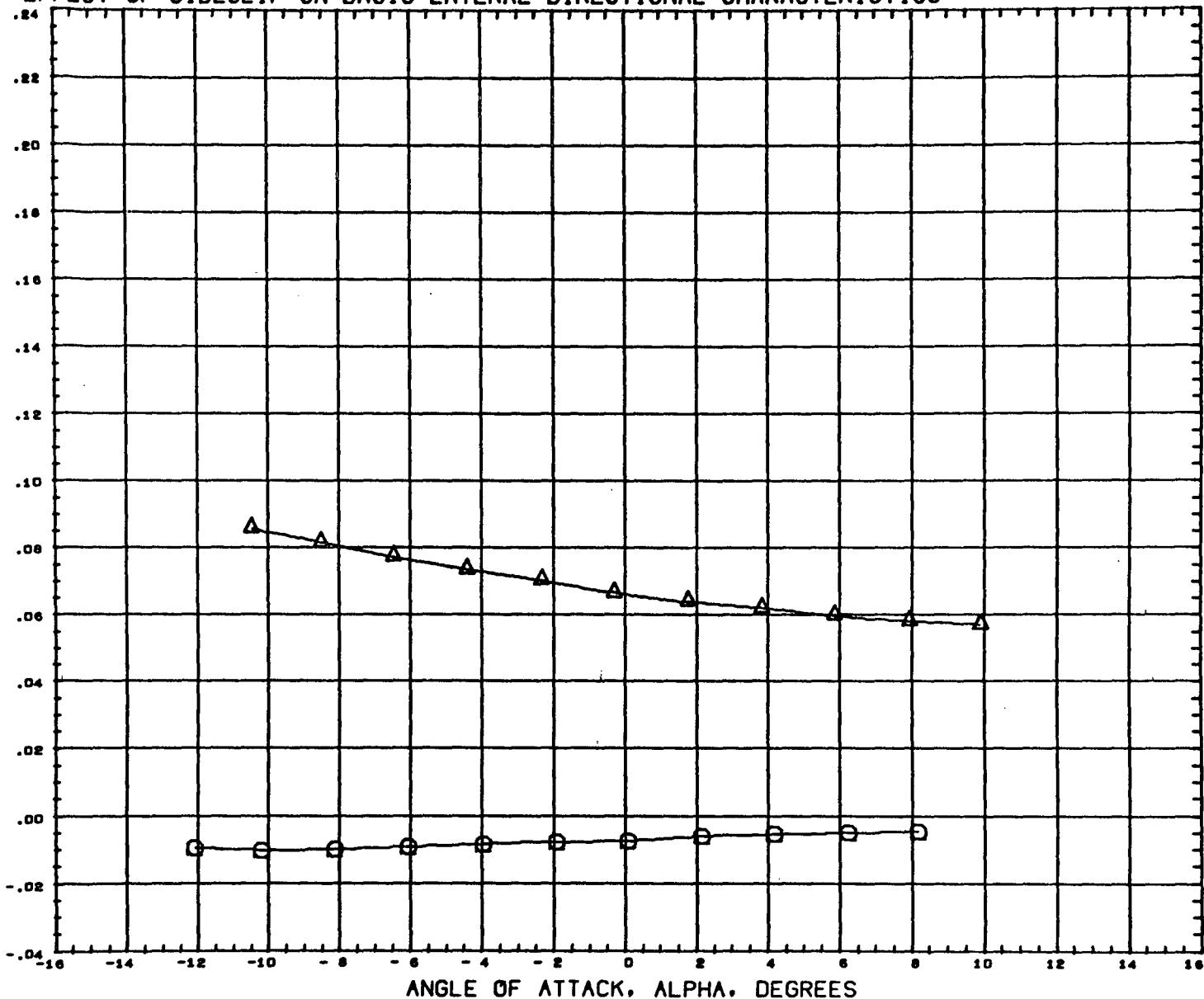
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MACH 1.961

PAGE 106

## EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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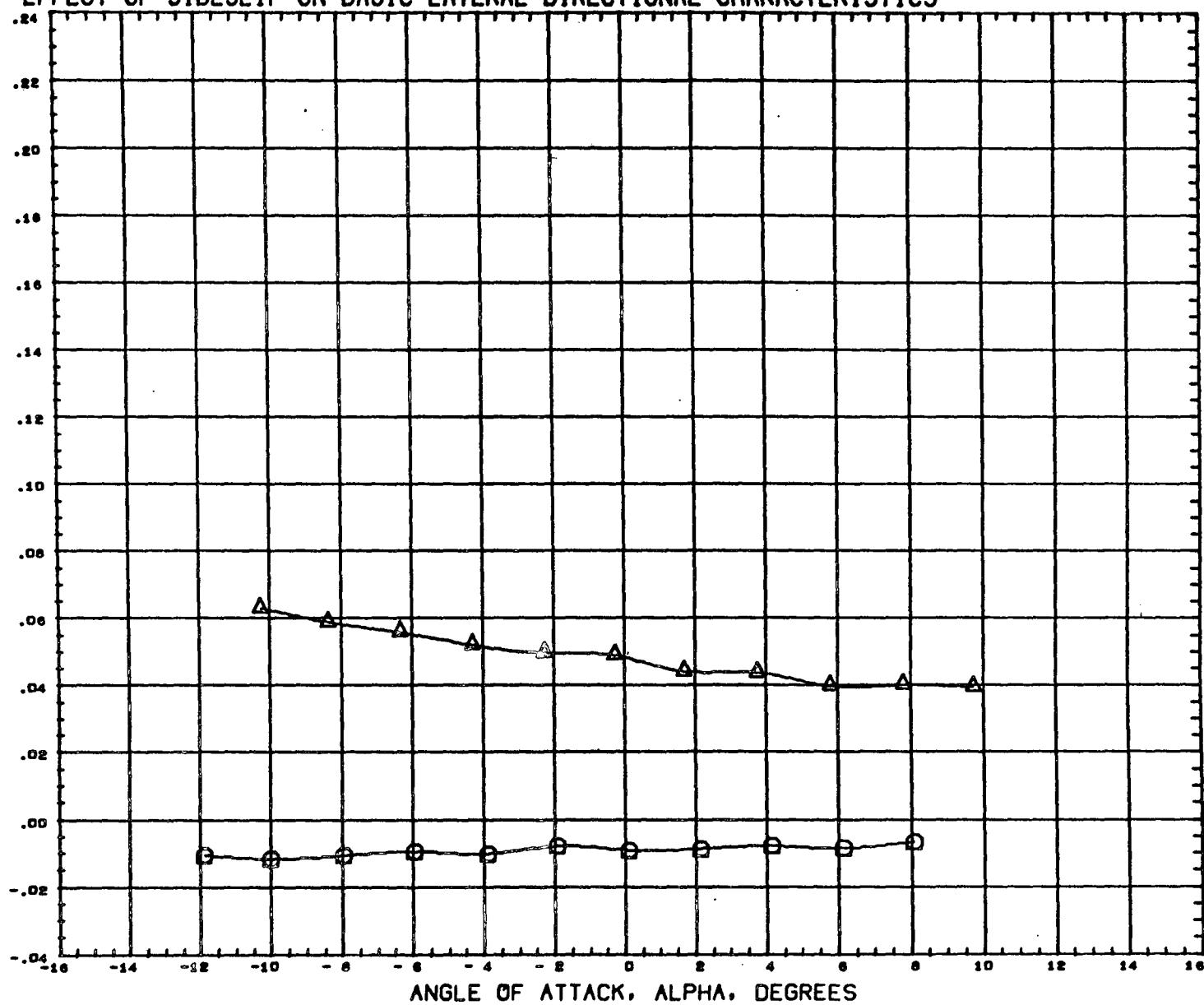
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 SCALE 0.0044 SCALE

MACH 2.990

PAGE 107

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) M8FC509 NR 110C ORBITER B12W26E16V36  
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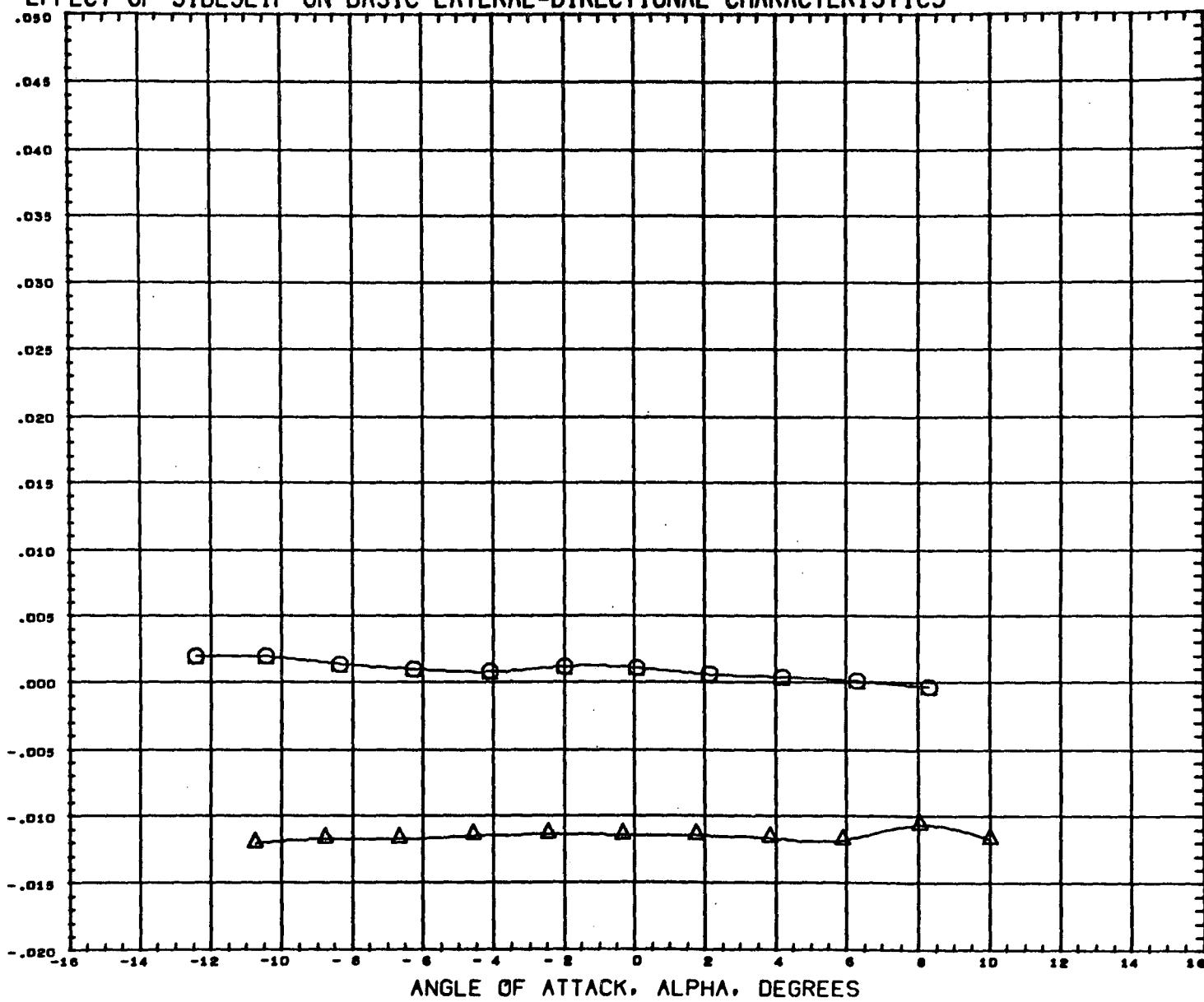
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 SCALE 0.0044 SCALE

MACH 4.059

PAGE 108

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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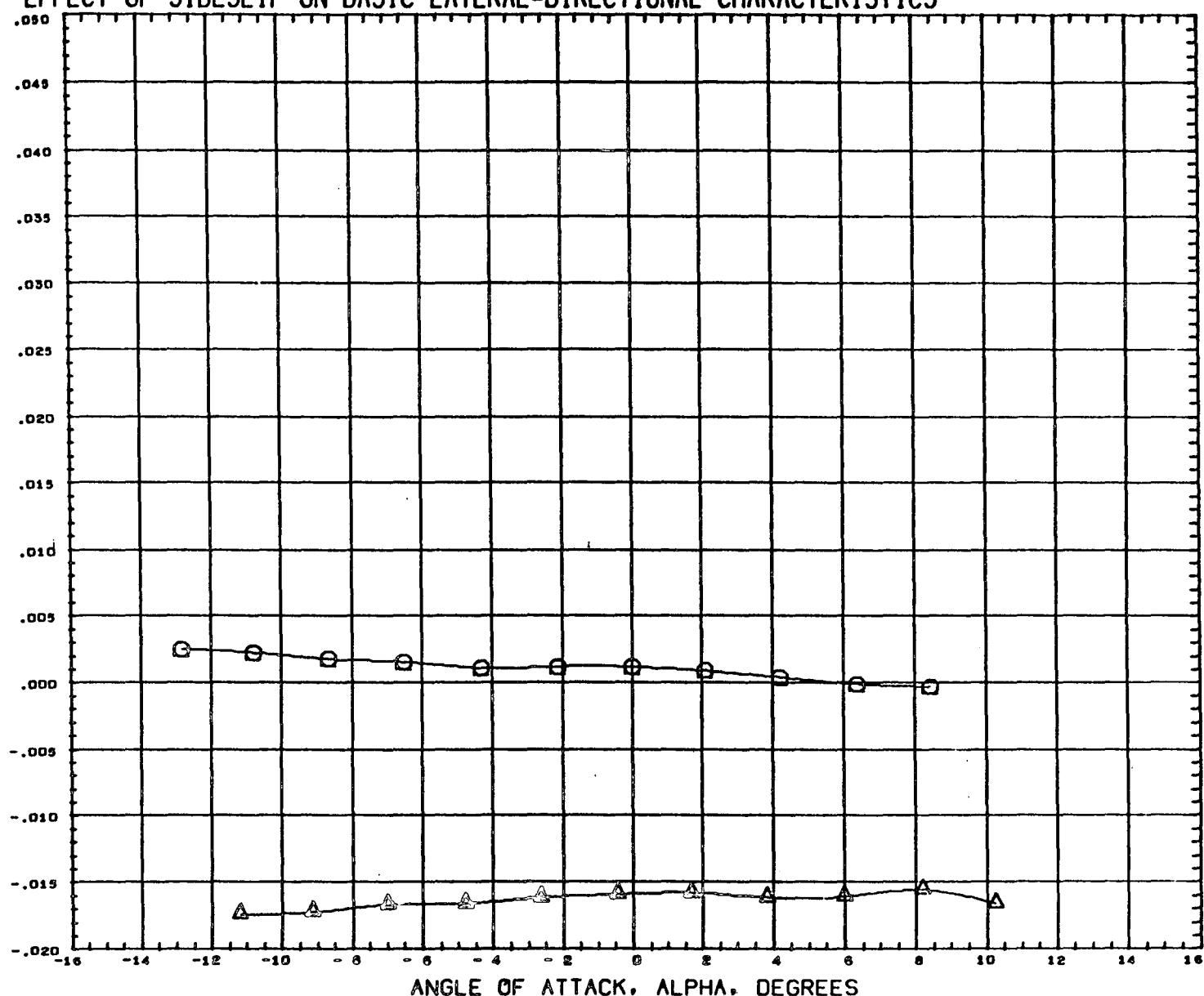
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 SCALE 0.0044 SCALE

MACH 0.605

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



ANGLE OF ATTACK, ALPHA, DEGREES

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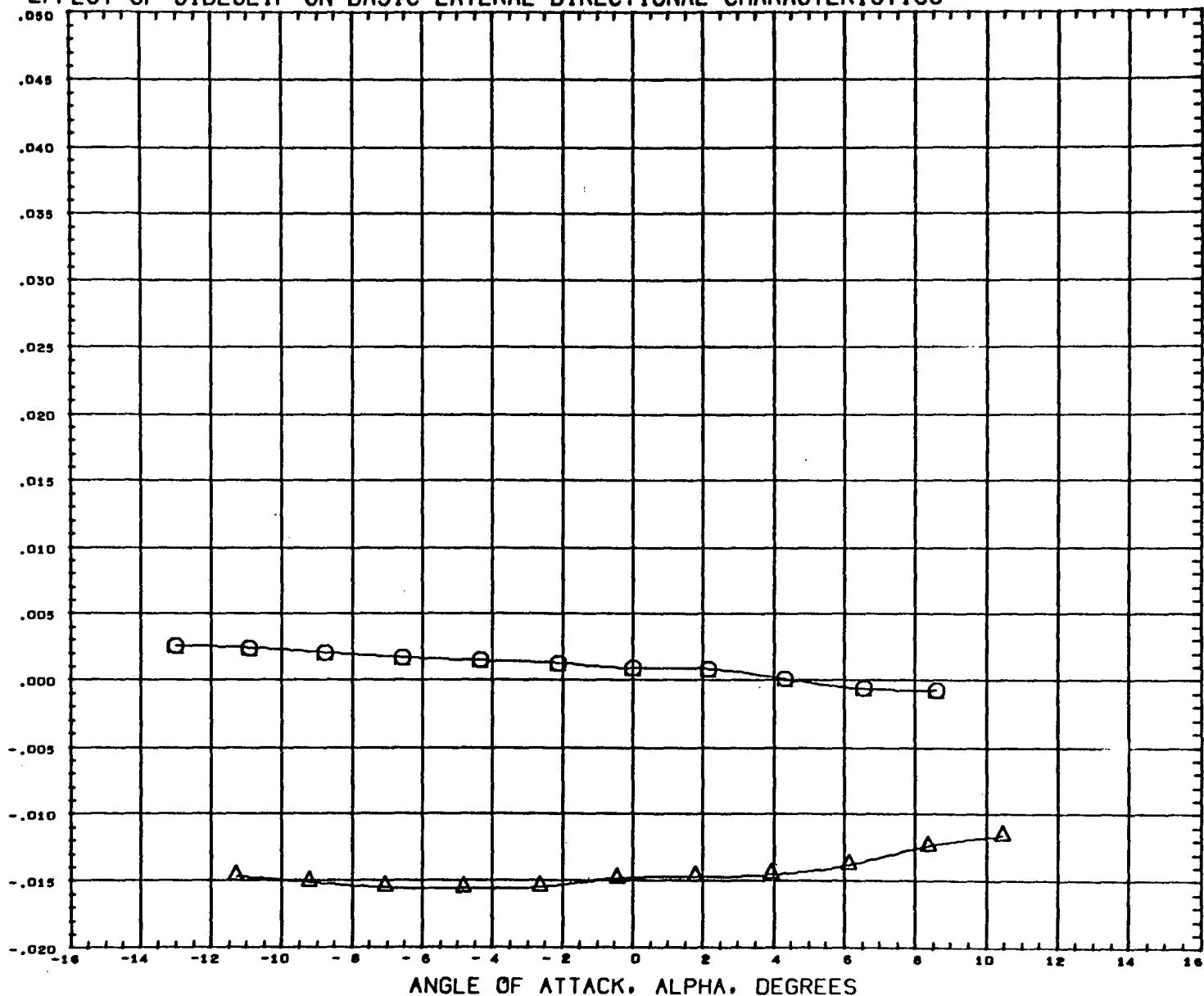
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.698

PAGE 110

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) MSFC509 NR 110C ORBITER B12W26E16V36  
 (B5102A) MSFC509 NR 110C ORBITER B12W26E16V36

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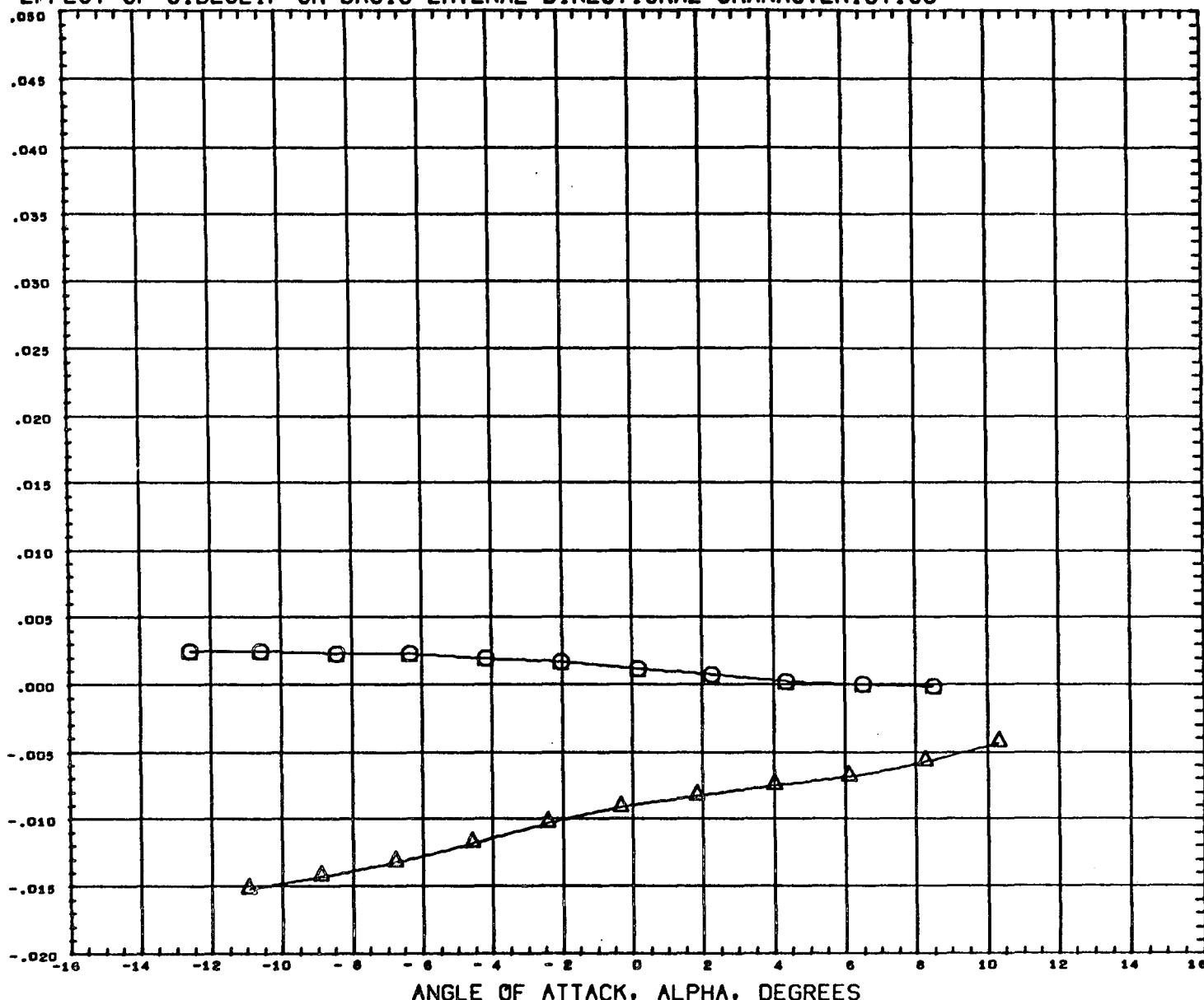
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 ZHRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 2.194

PAGE 111

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
 (B5102A) MSFC509 NR 11OC ORBITER B12W26E16V36

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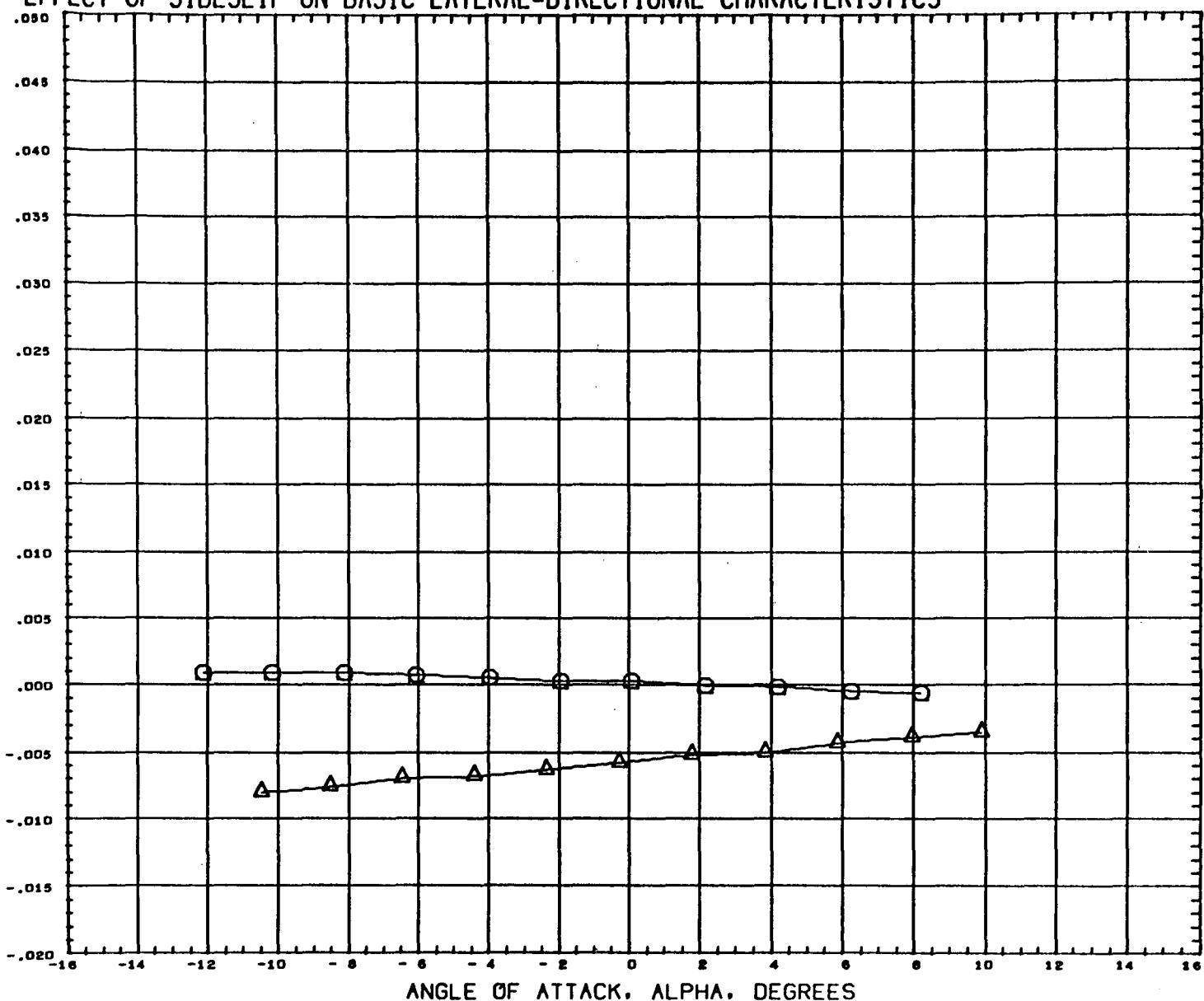
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.961

PAGE 112

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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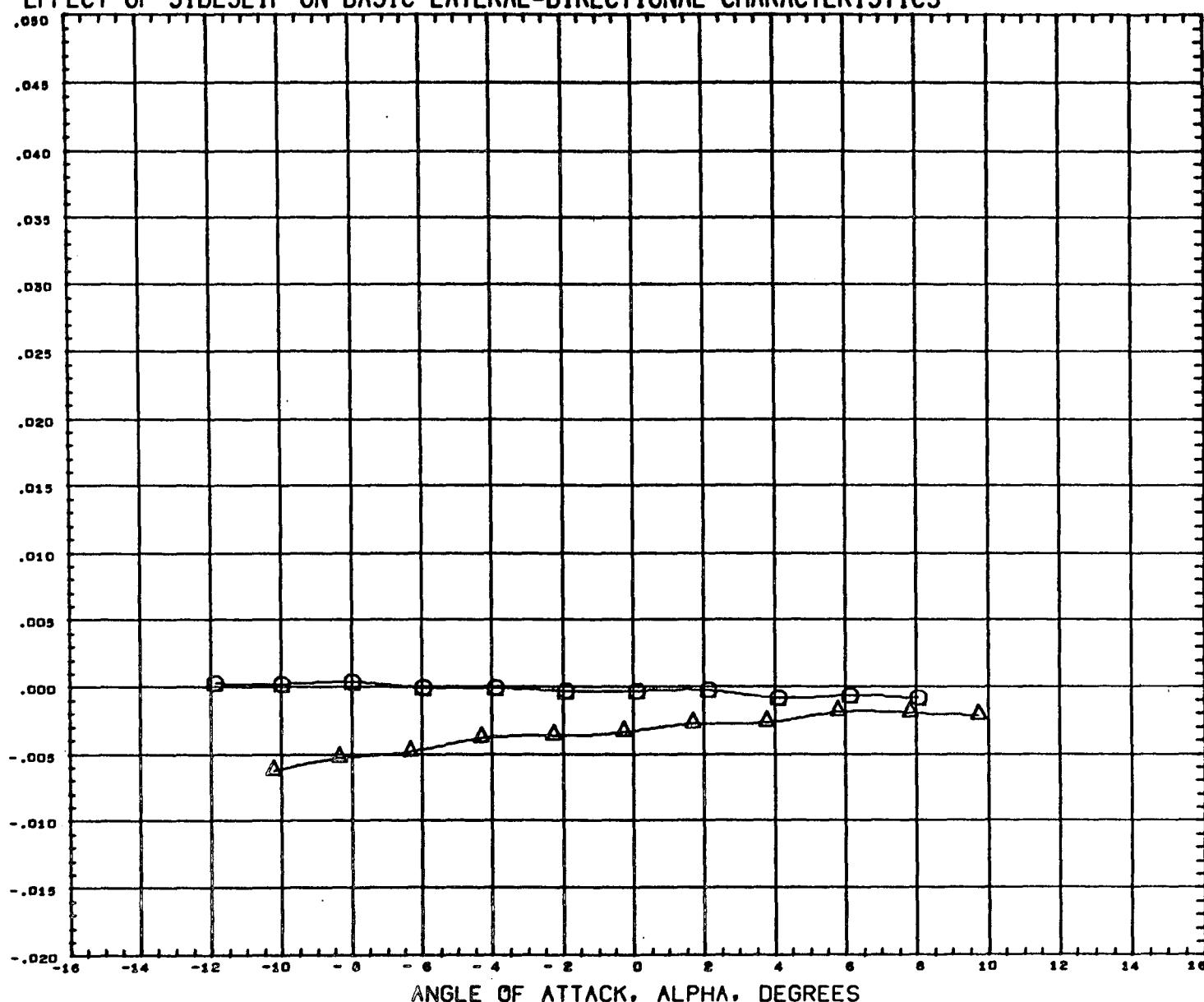
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 SCALE 0.0044 SCALE

MACH 2.000

PAGE 113

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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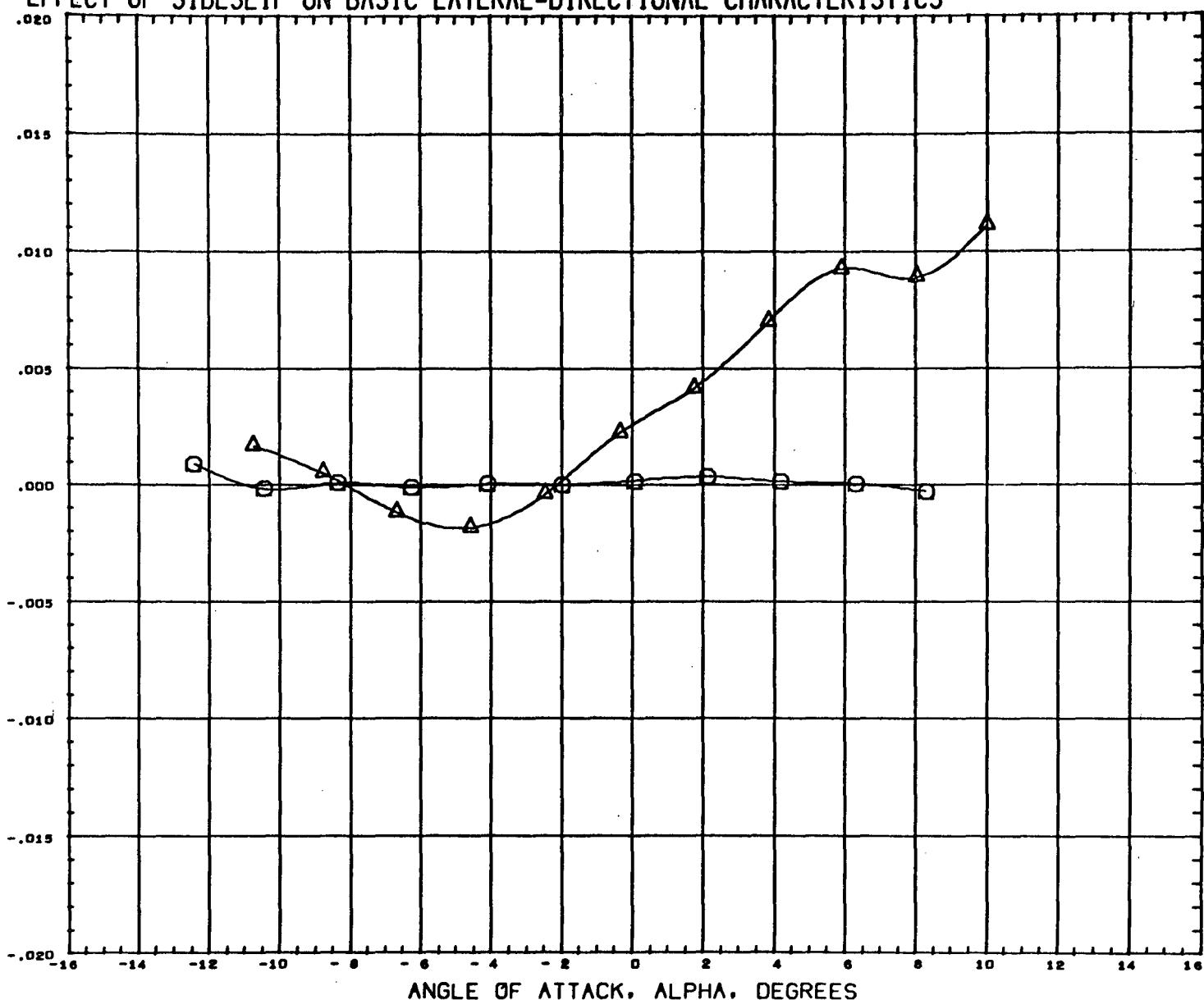
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MACH 4.050

PAGE 114

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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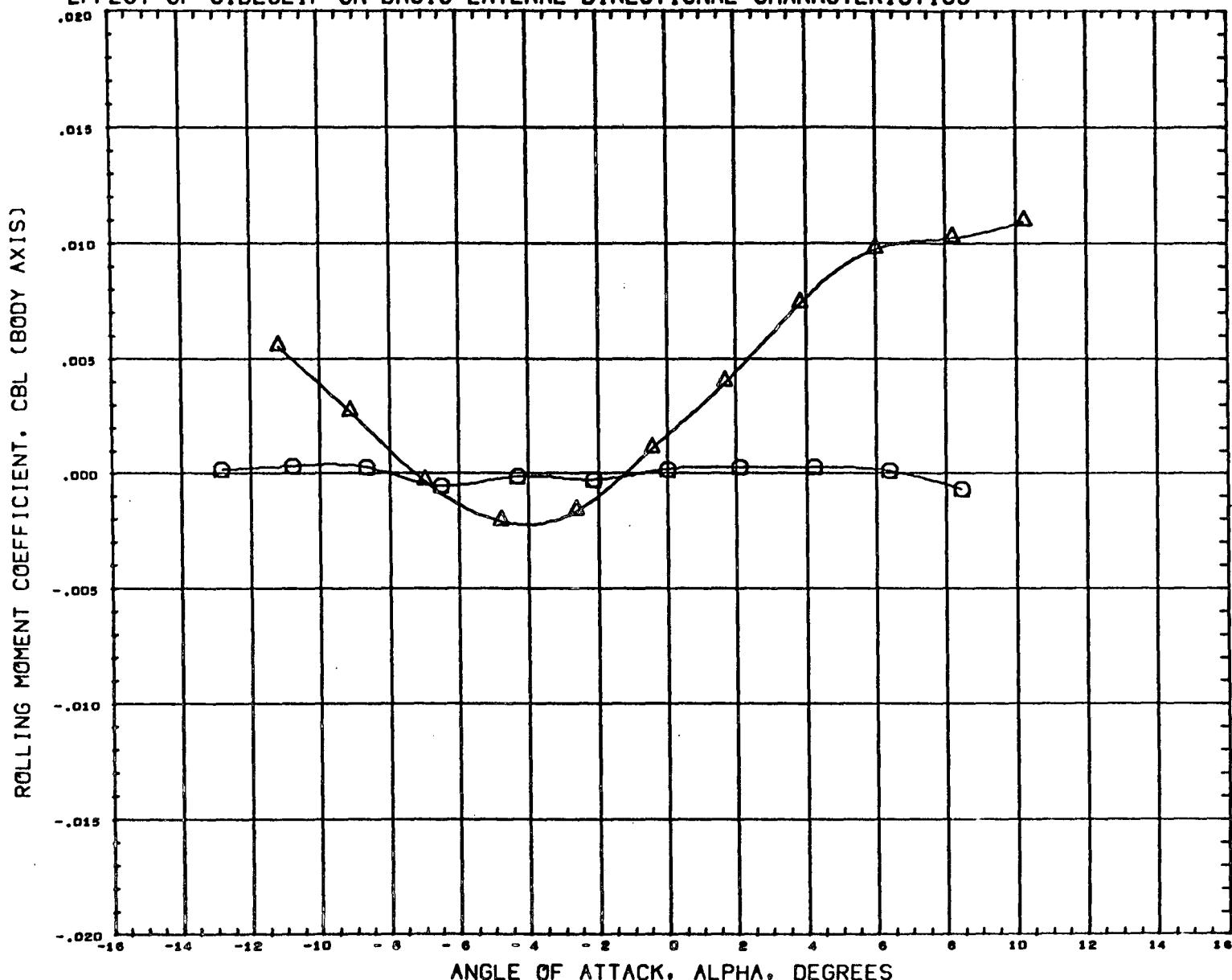
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 ZHRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.605

PAGE 115

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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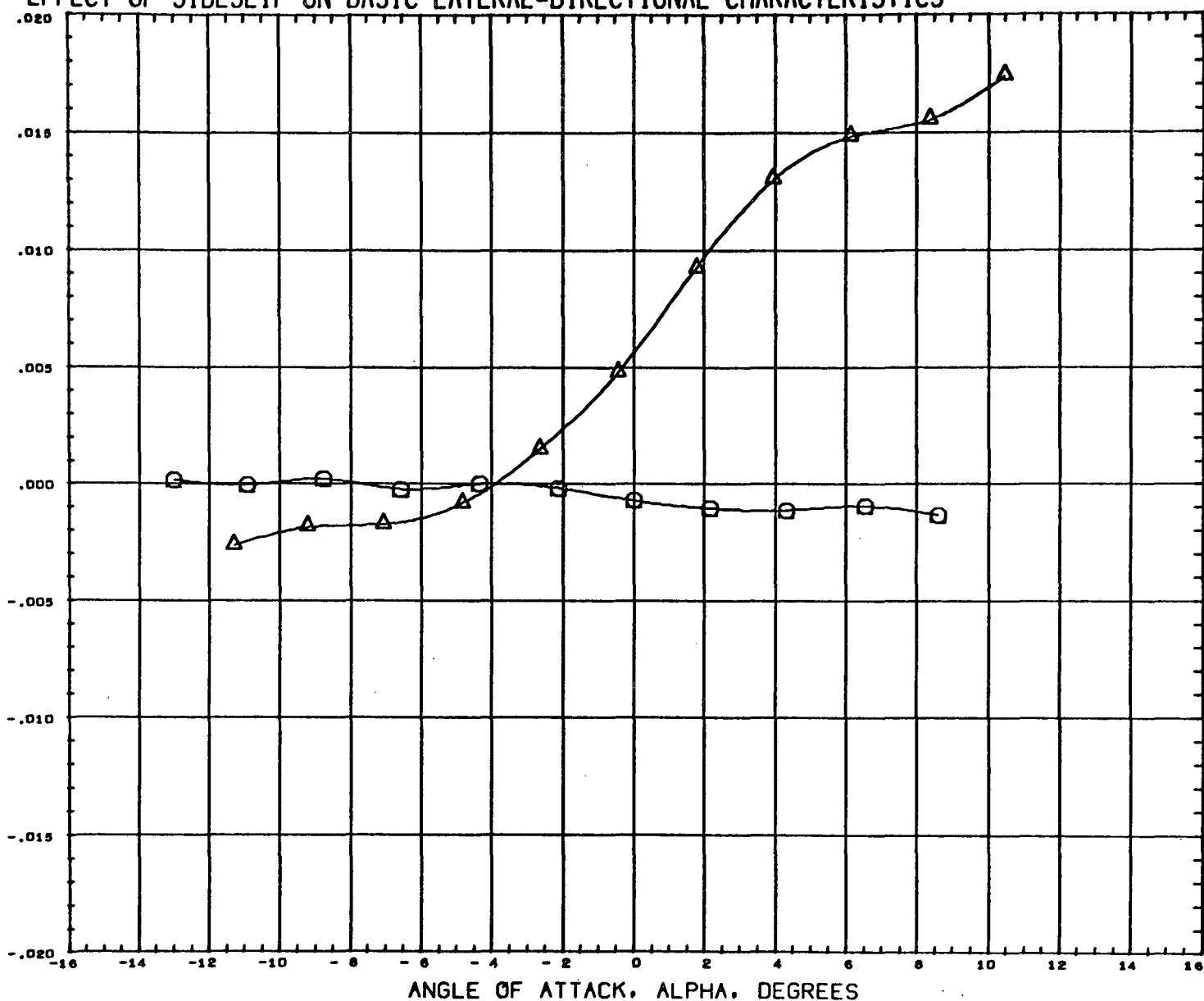
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 SCALE 0.0044 SCALE

MACH 0.698

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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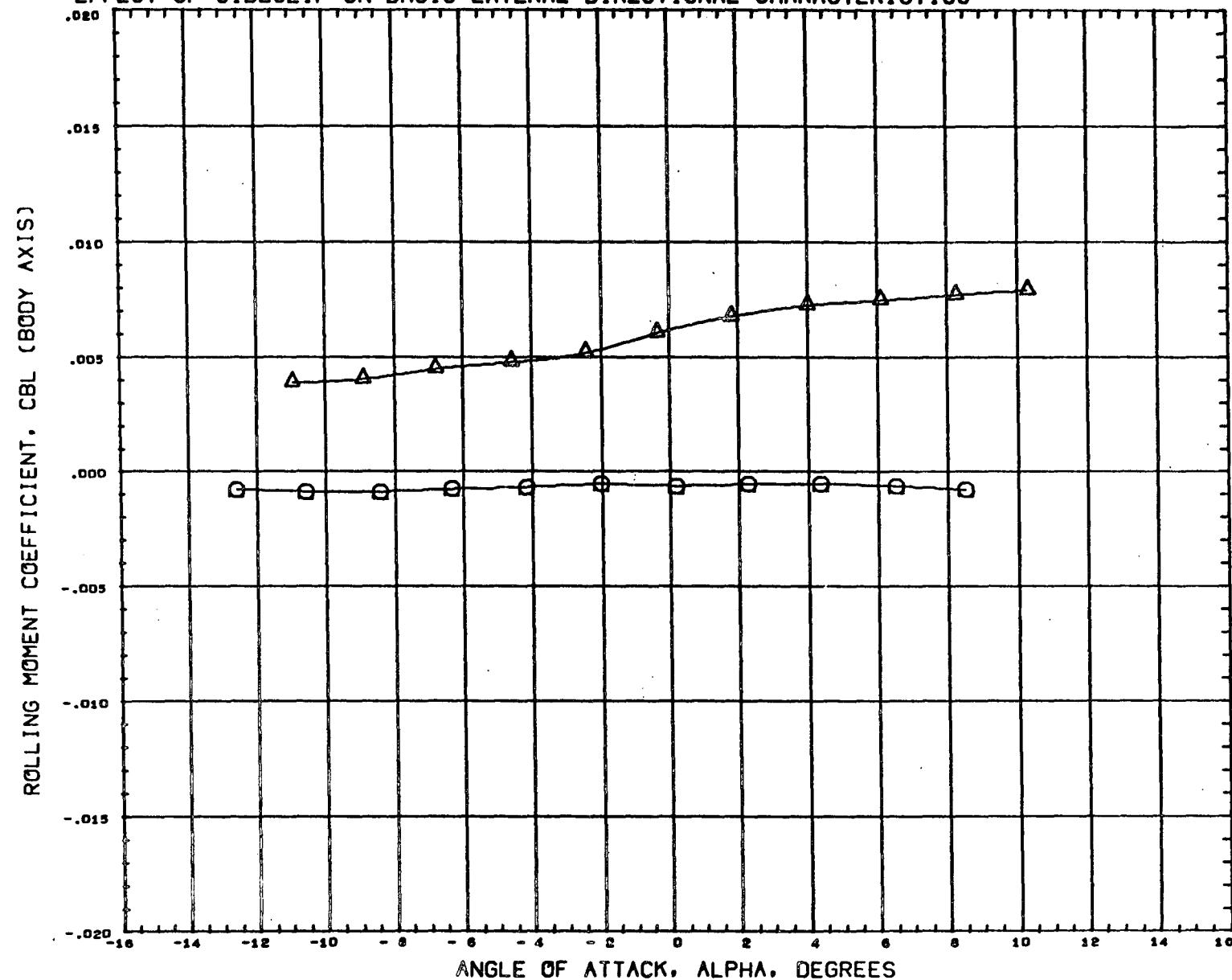
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.194

PAGE 117

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) M8FC509 NR 11OC ORBITER B12W26E16V36  
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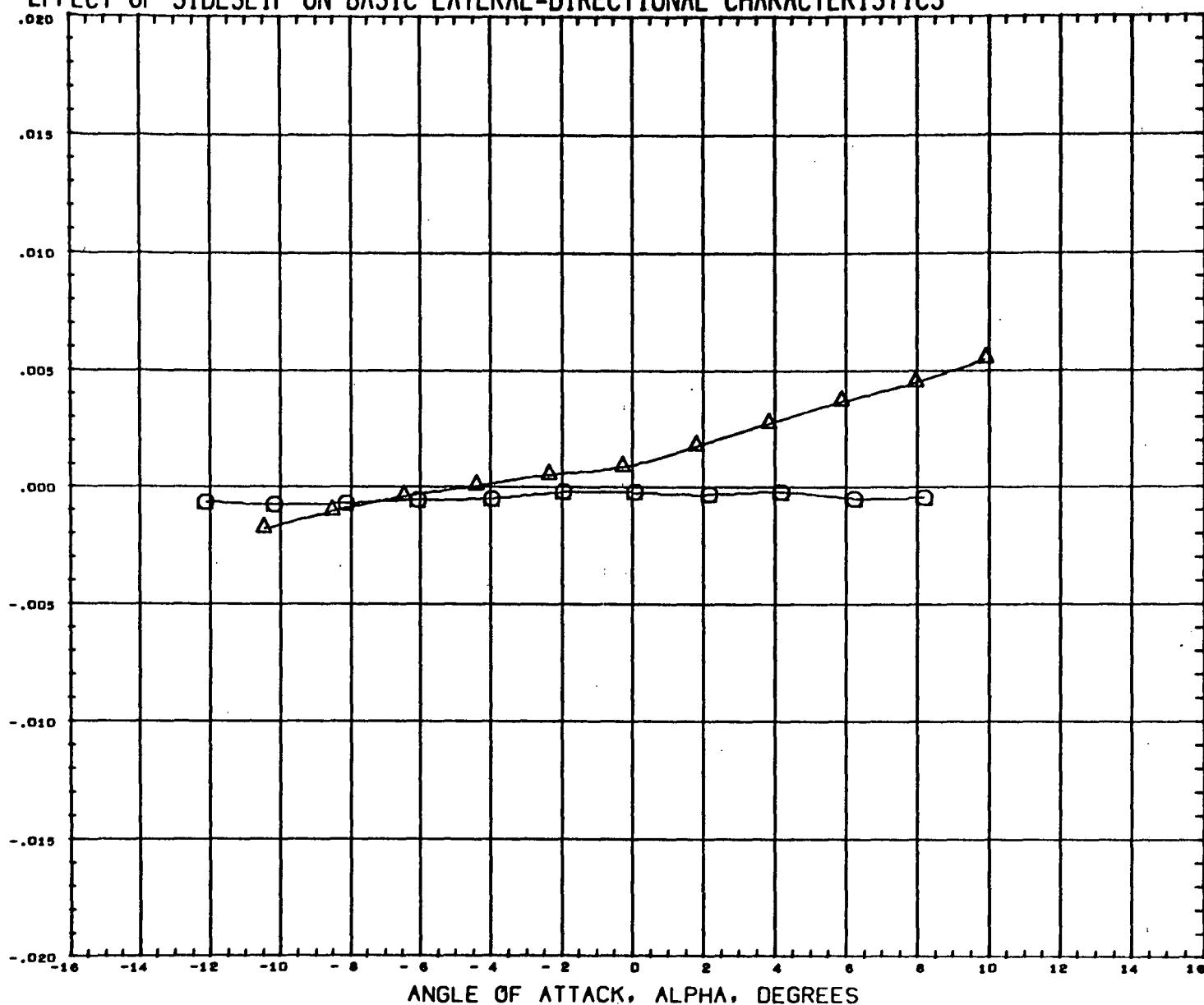
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 SCALE 0.0044 SCALE

MACH 2.061

PAGE 118

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) MSFC509 NR 110C ORBITER B12W26E16V36  
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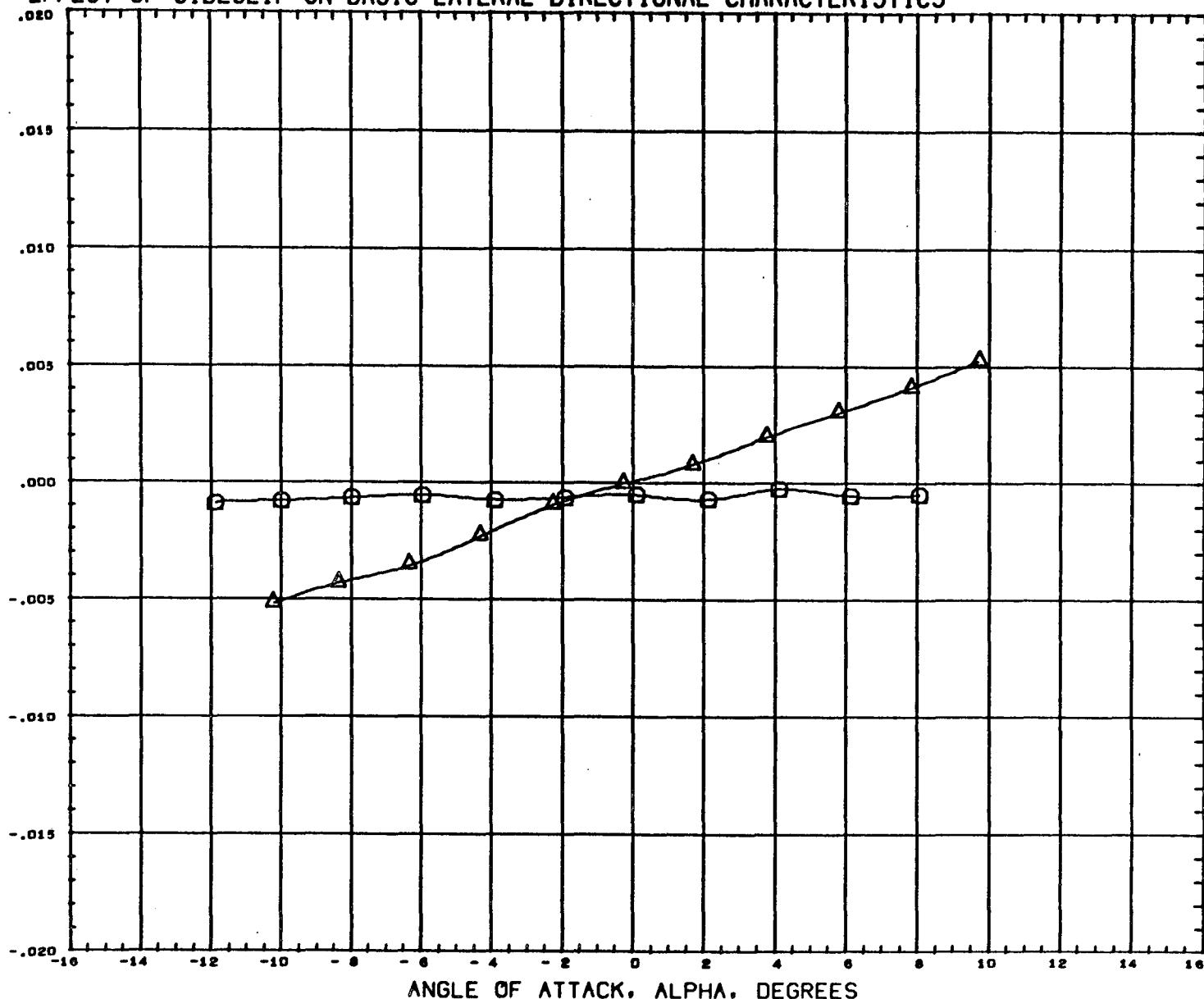
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 2.990

PAGE 119

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5101A) MSFC5D9 NR 11OC ORBITER B12W26E16V36  
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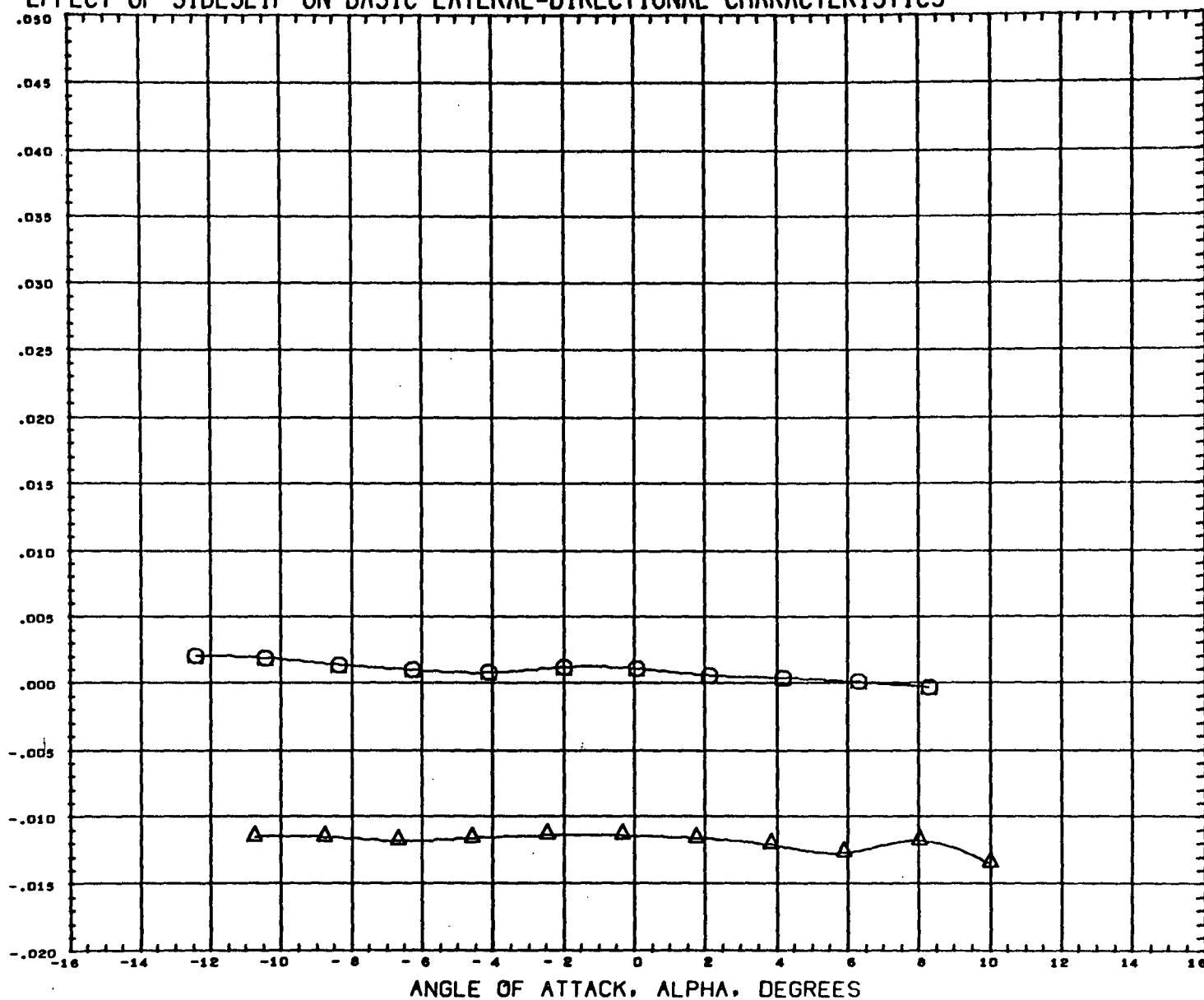
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 SCALE 0.0044 SCALE

MACH 4.959

PAGE 120

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



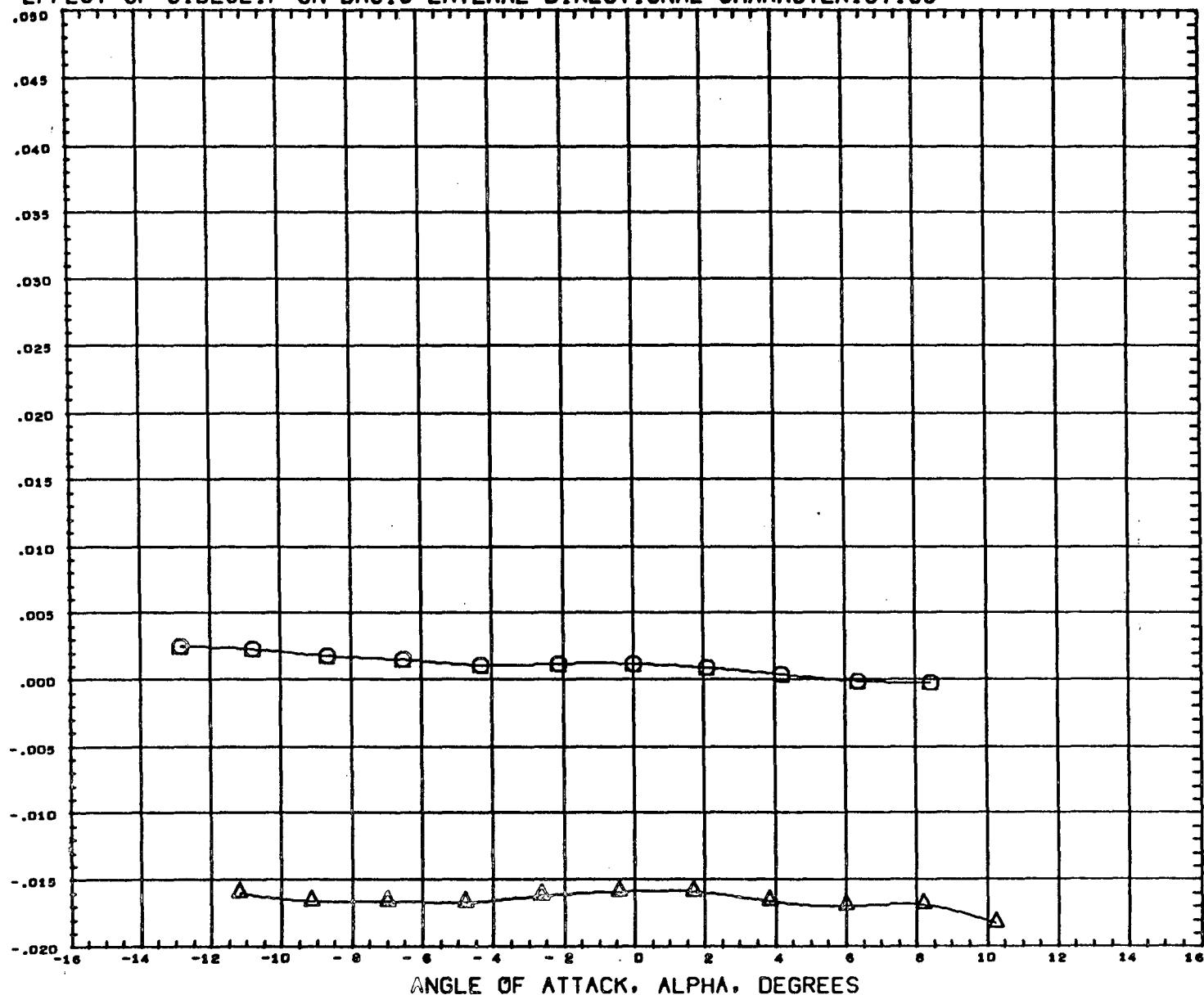
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MACH 0.605

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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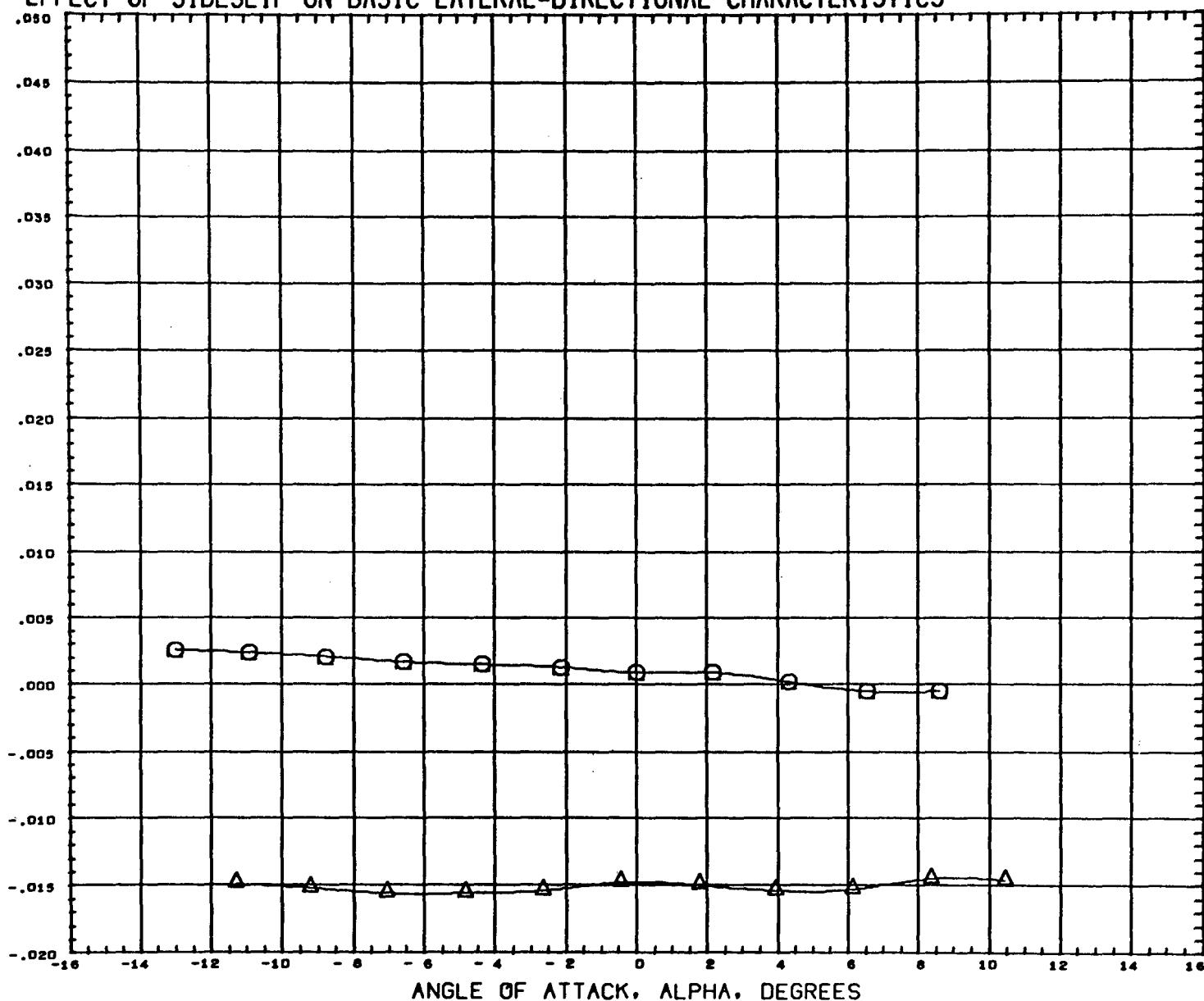
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 SCALE 0.0044 SCALE

MACH 0.898

PAGE 122

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (A5101A) MSFC509 NR 110C ORBITER B12W26E16V36  
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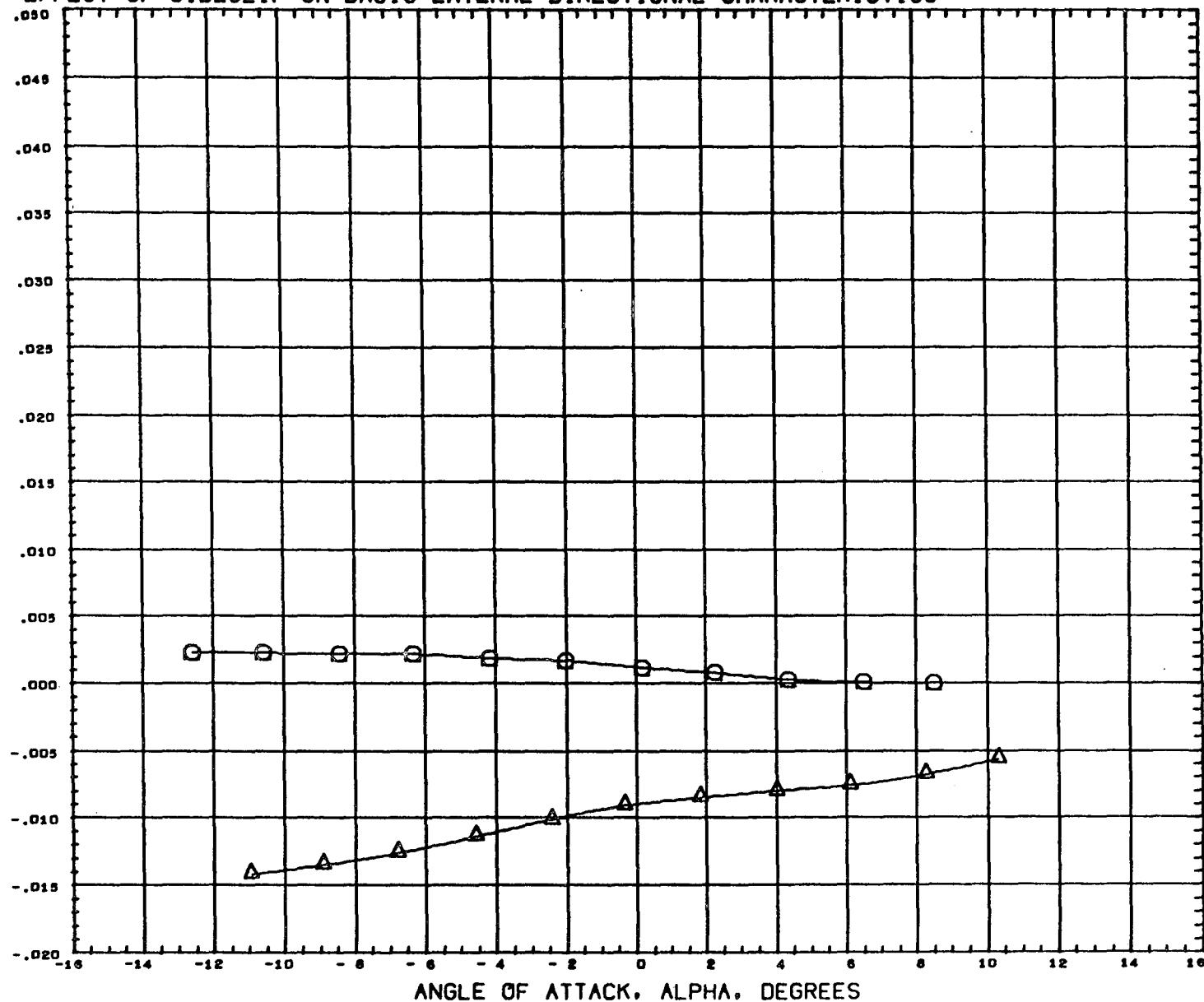
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 SCALE 0.0044 SCALE

MACH 1.194

PAGE 123

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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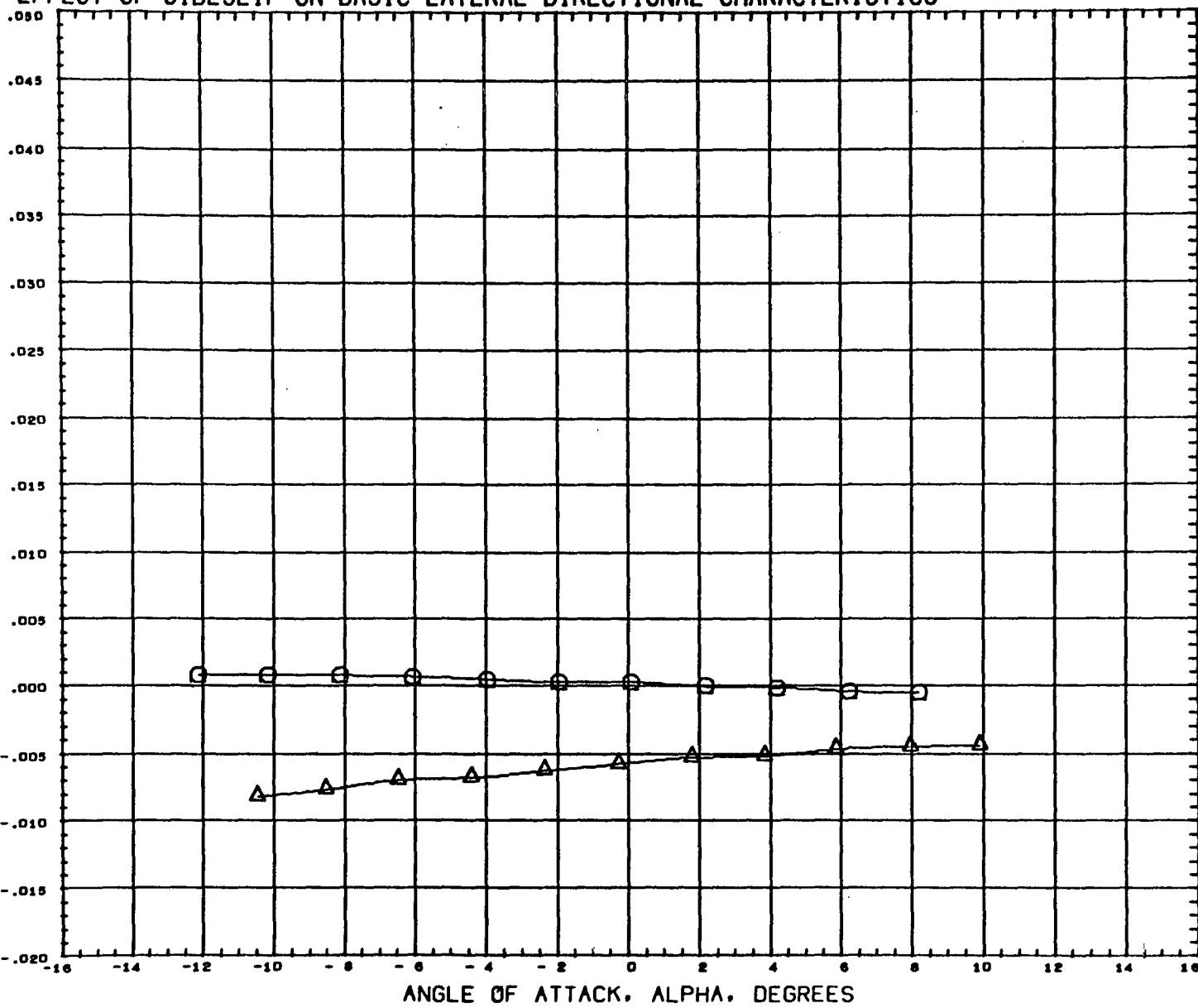
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.961

PAGE 124

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (A51D1A) M5FC509 NR 11OC ORBITER B12W26E16V36  
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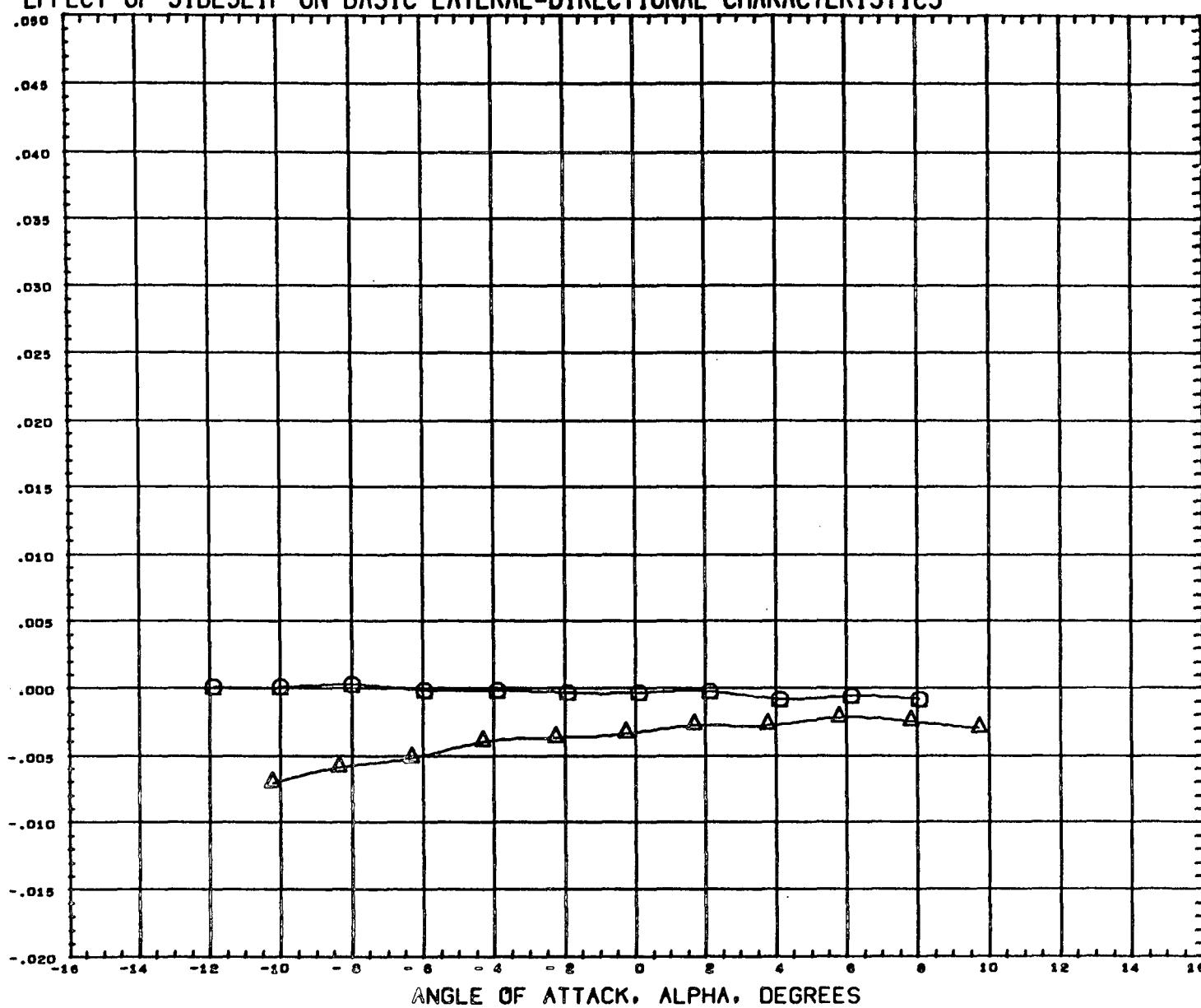
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 ZMRP - 0.099D INCHES  
 SCALE 0.0044 SCALE

MACH 2.990

PAGE 125

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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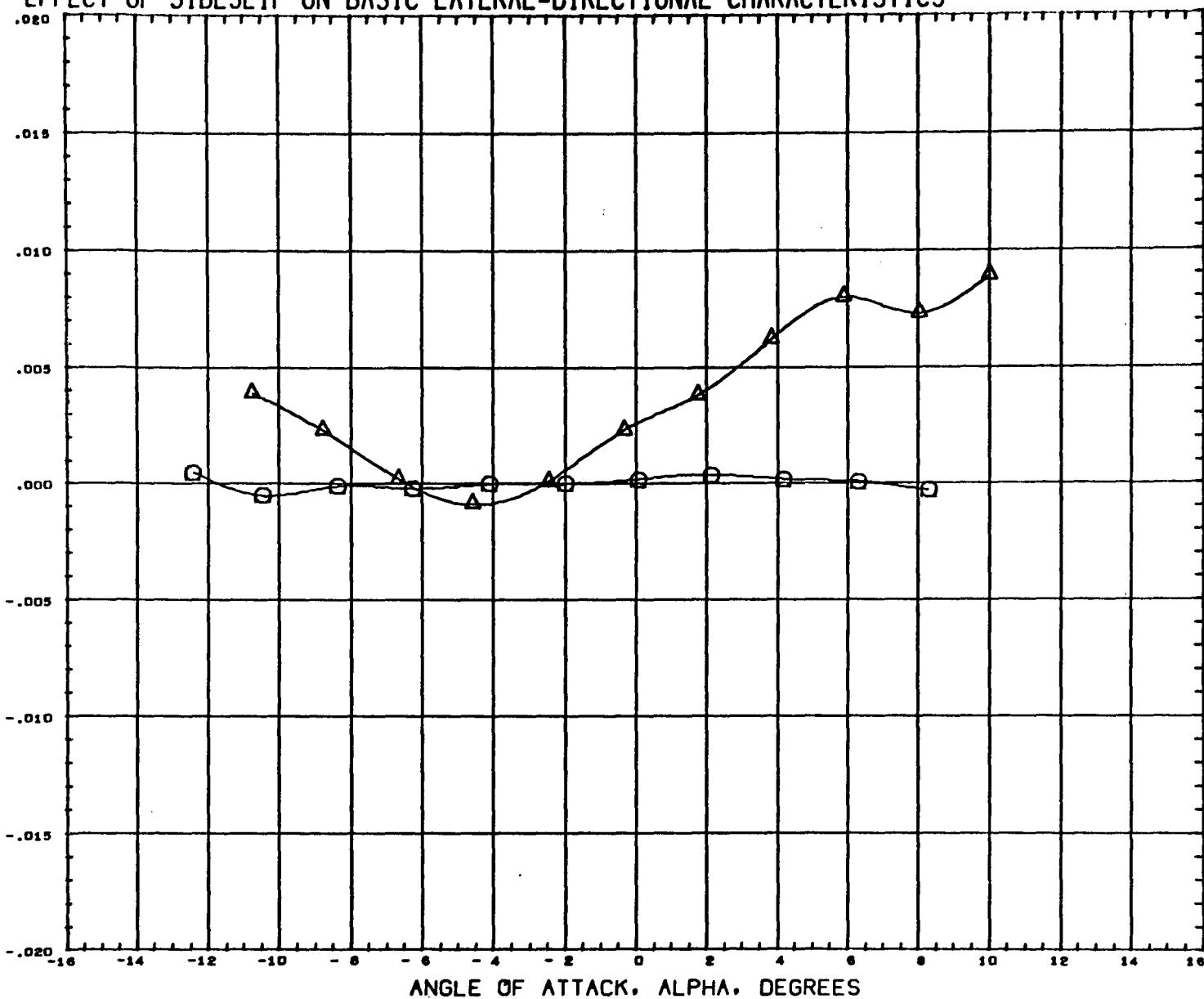
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 4.059

PAGE 126

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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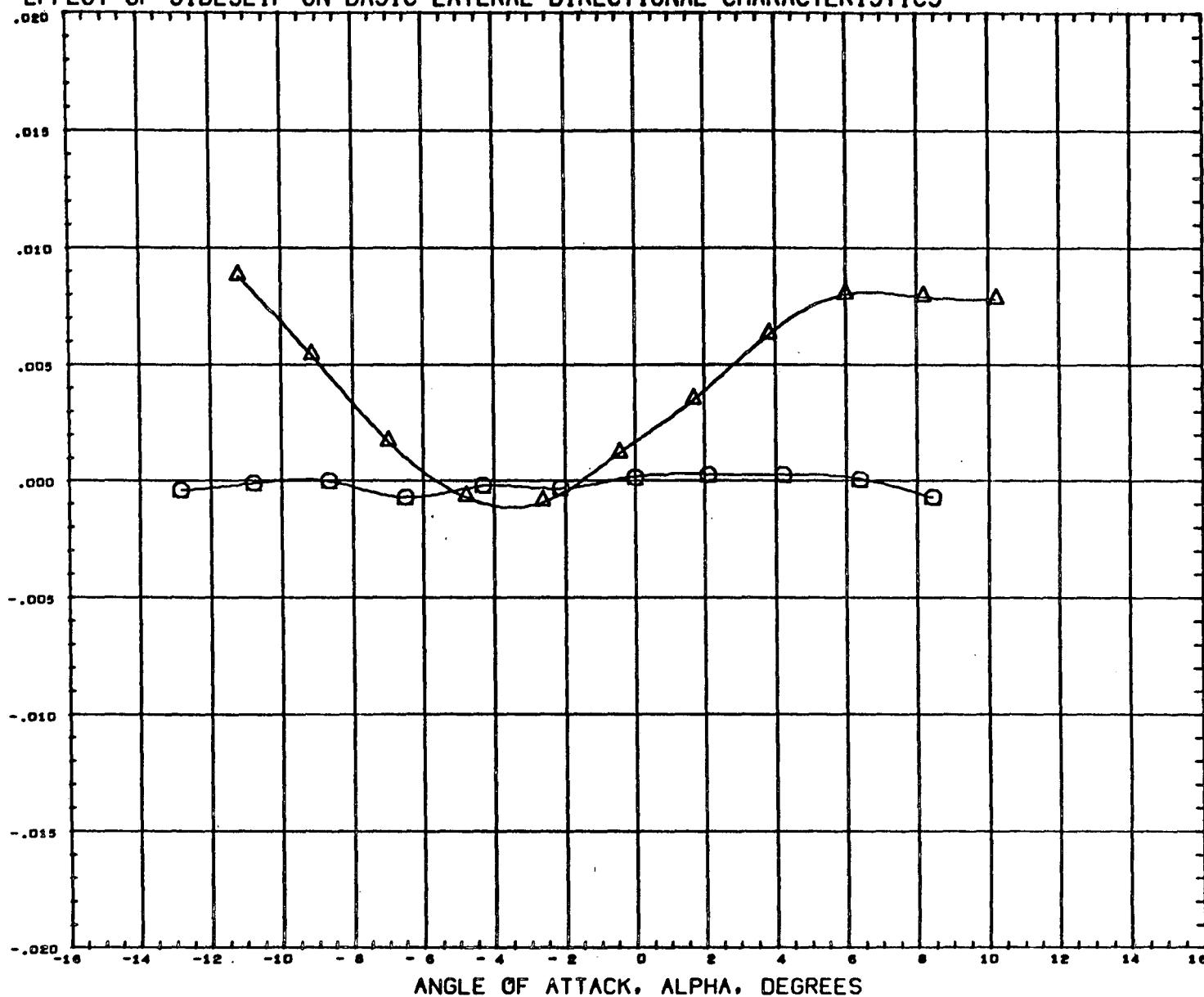
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.605

PAGE 127

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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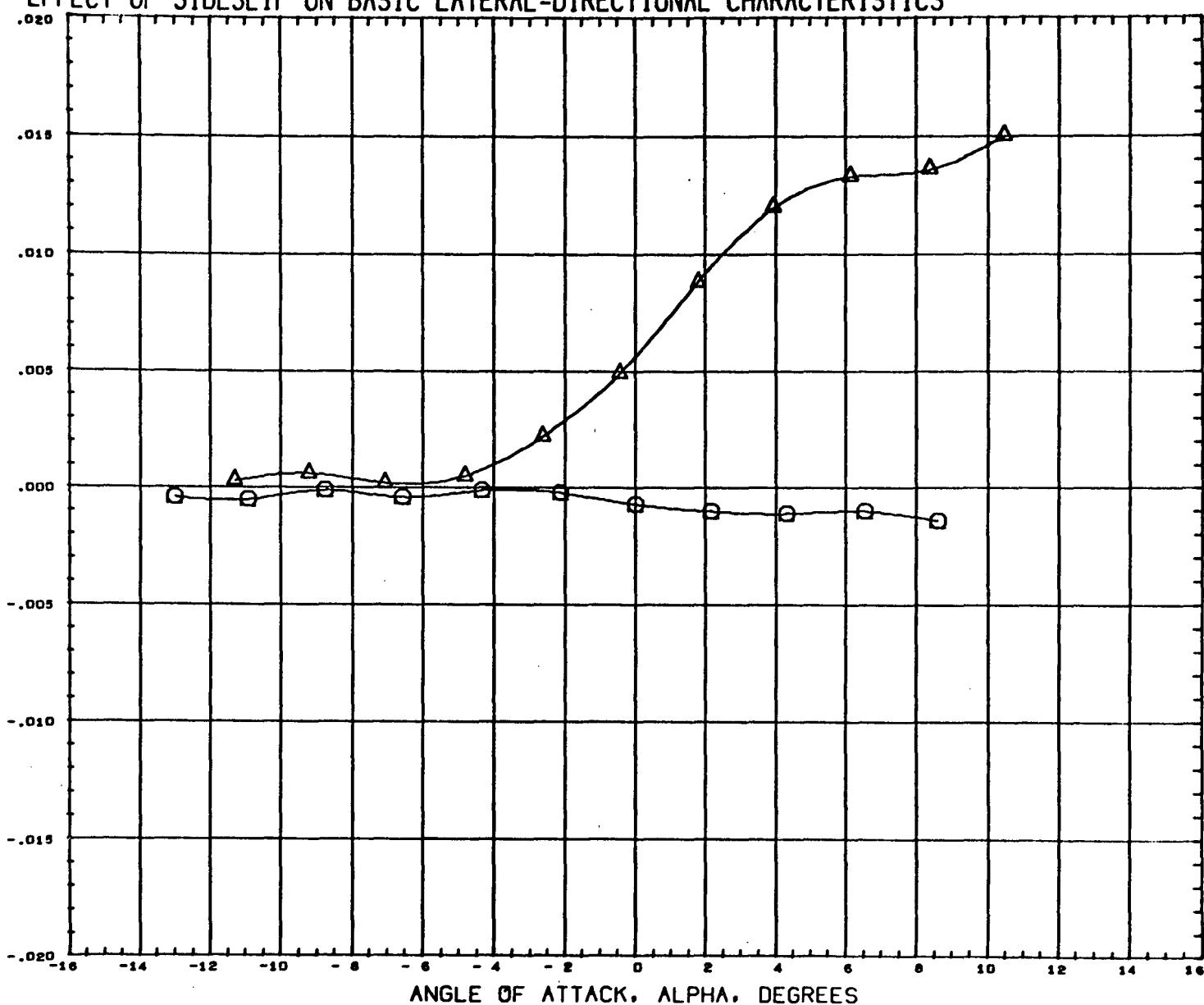
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 ZMRP 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.098

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (A5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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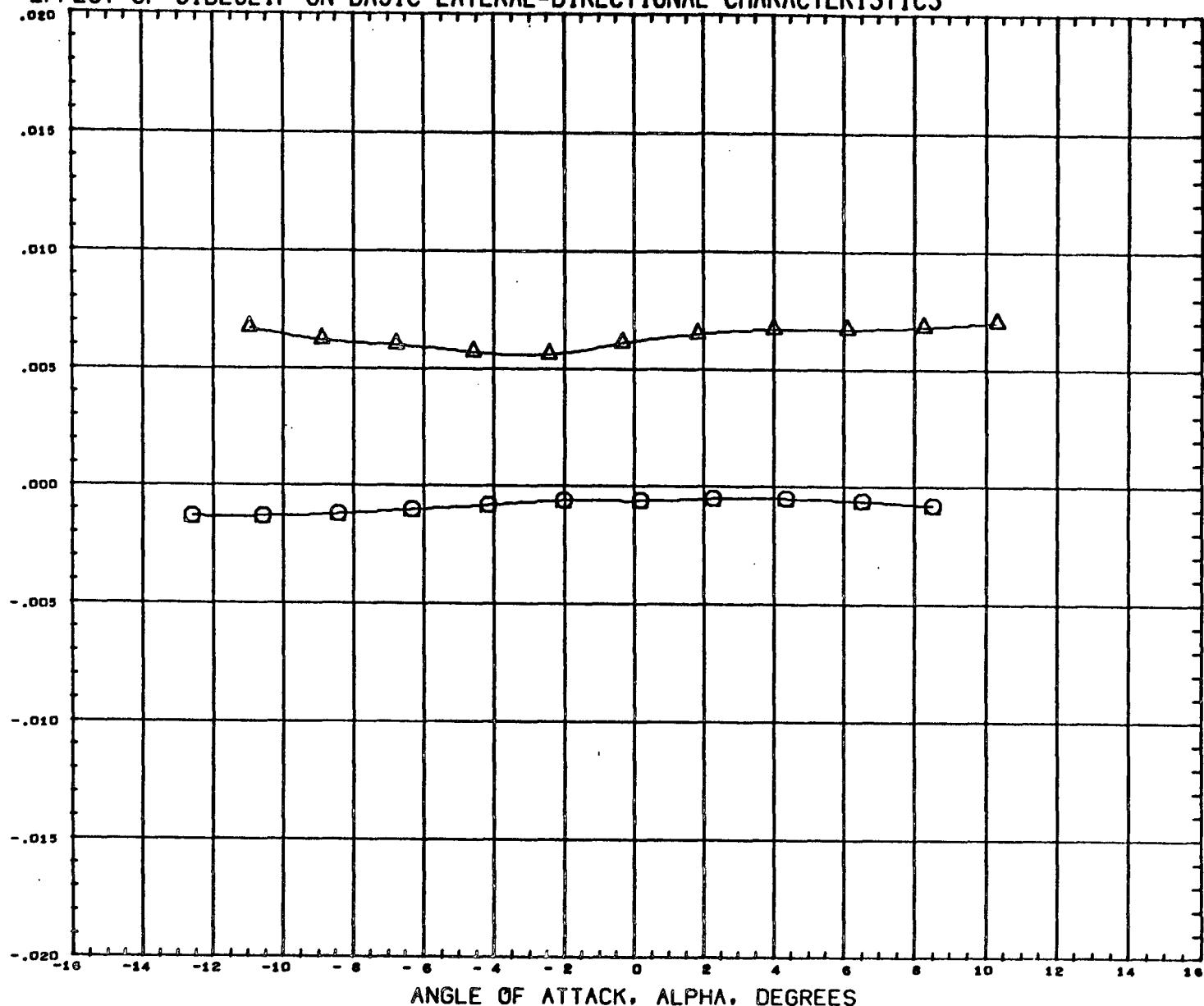
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 SCALE 0.0044 SCALE

MACH 1.194

PAGE 129

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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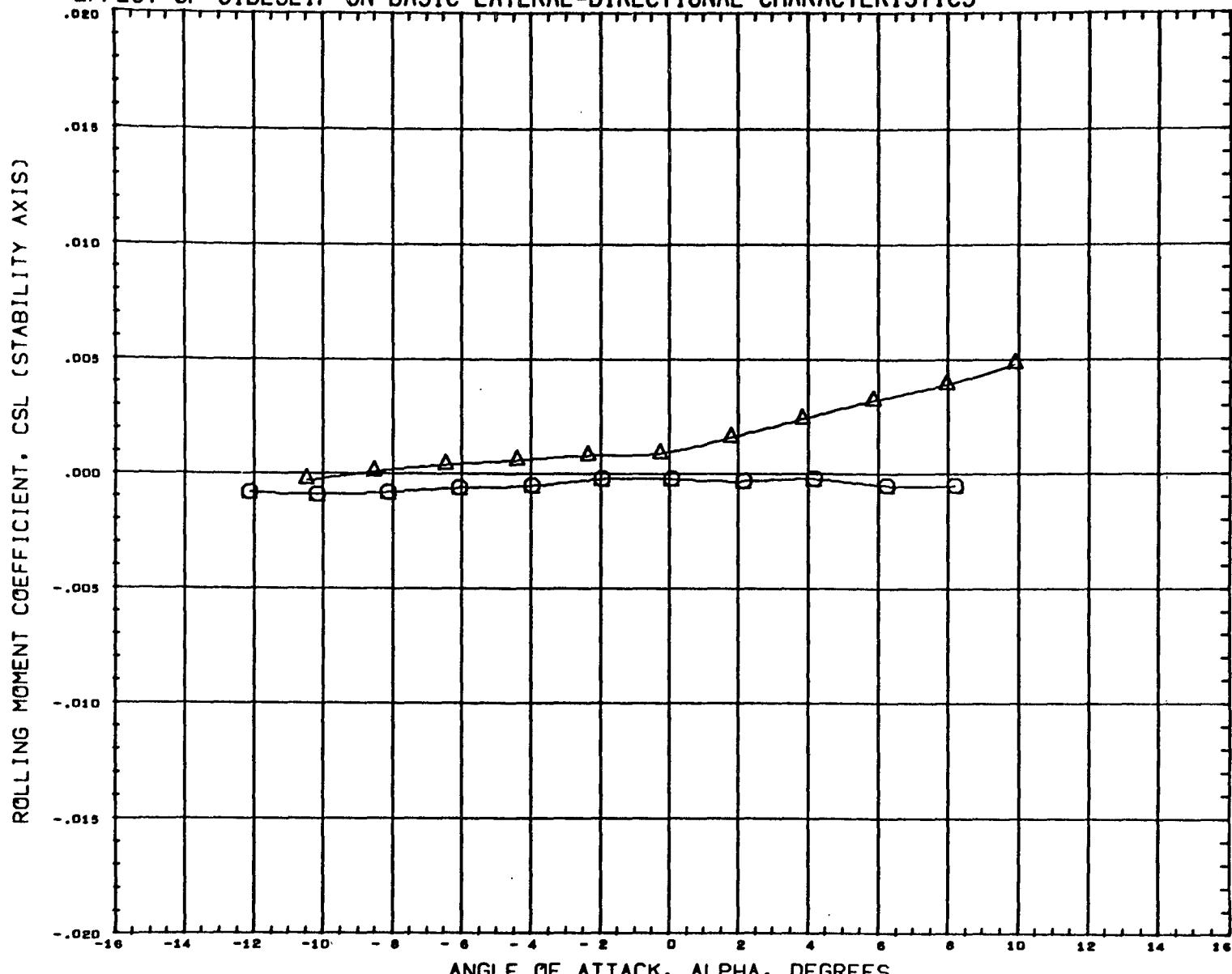
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 8.061

PAGE 130

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (A5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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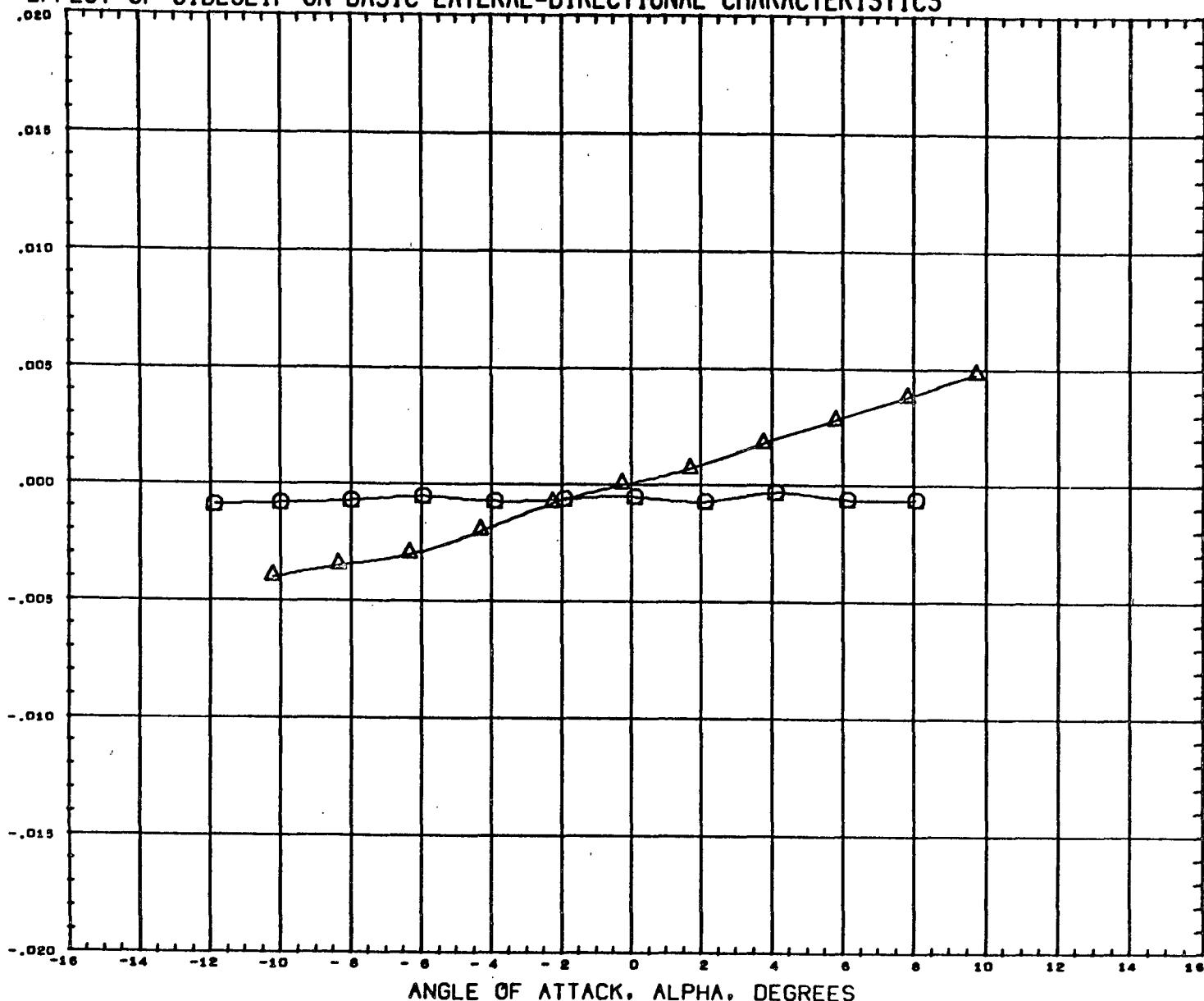
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 2.990

PAGE 131

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (A5101A) MSFC509 NR 11OC ORBITER B12W26E16V36  
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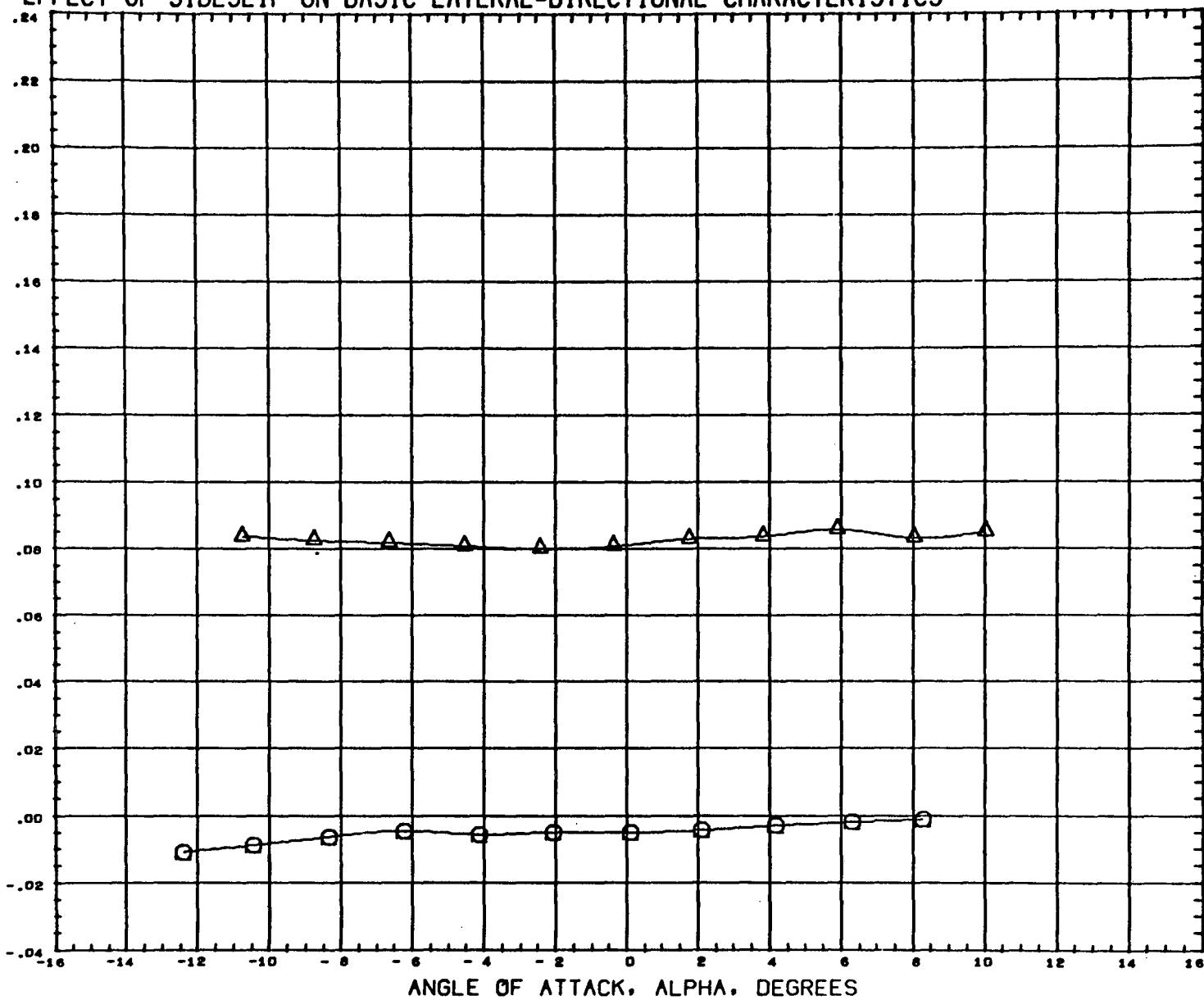
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 SCALE 0.0044 SCALE

MACH 4.059

PAGE 132

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5104A) MSFC5D9 NR 11OC ORBITER B14K3W26E16V36  
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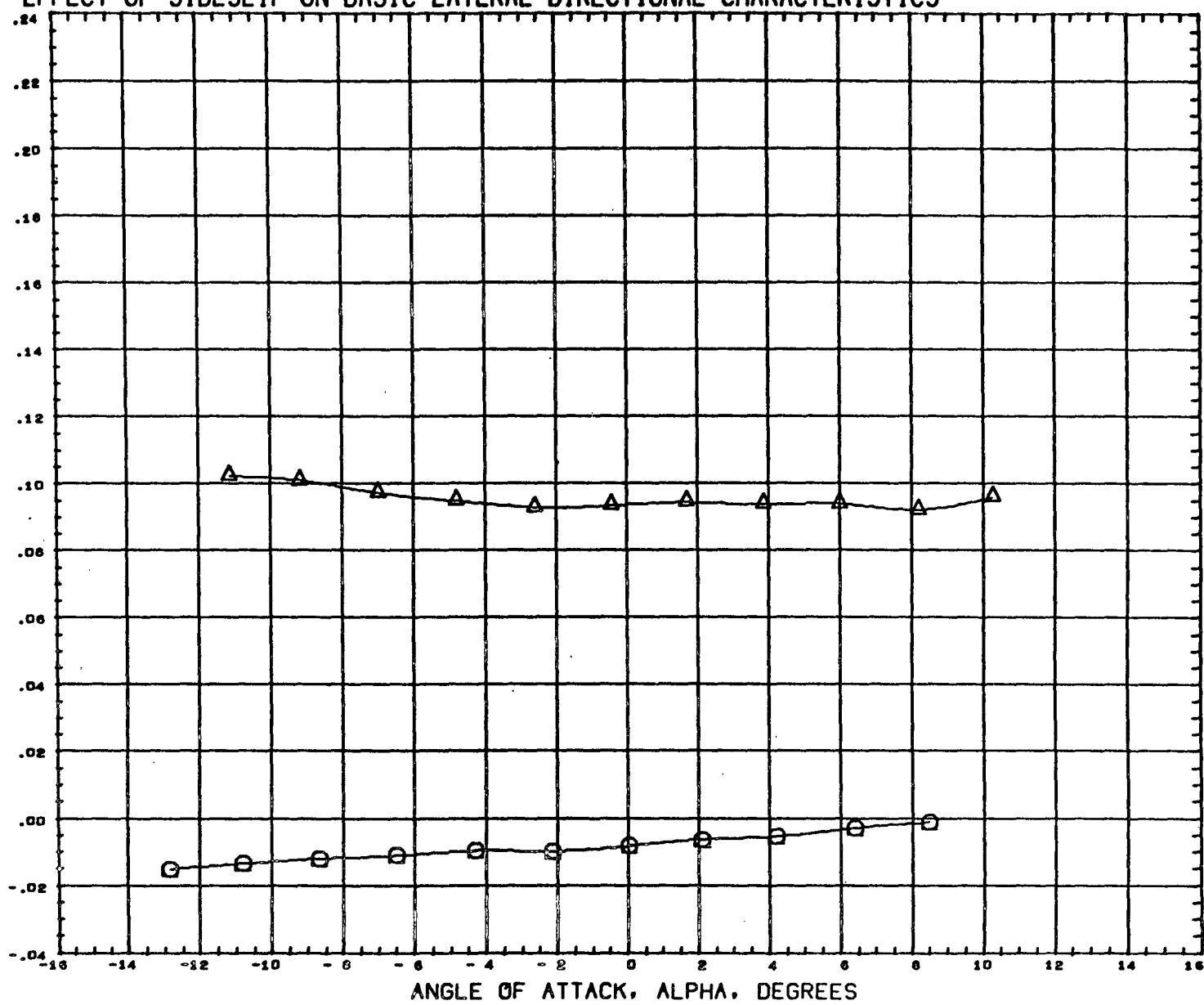
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 SCALE 0.0044 SCALE

MACH 0.601

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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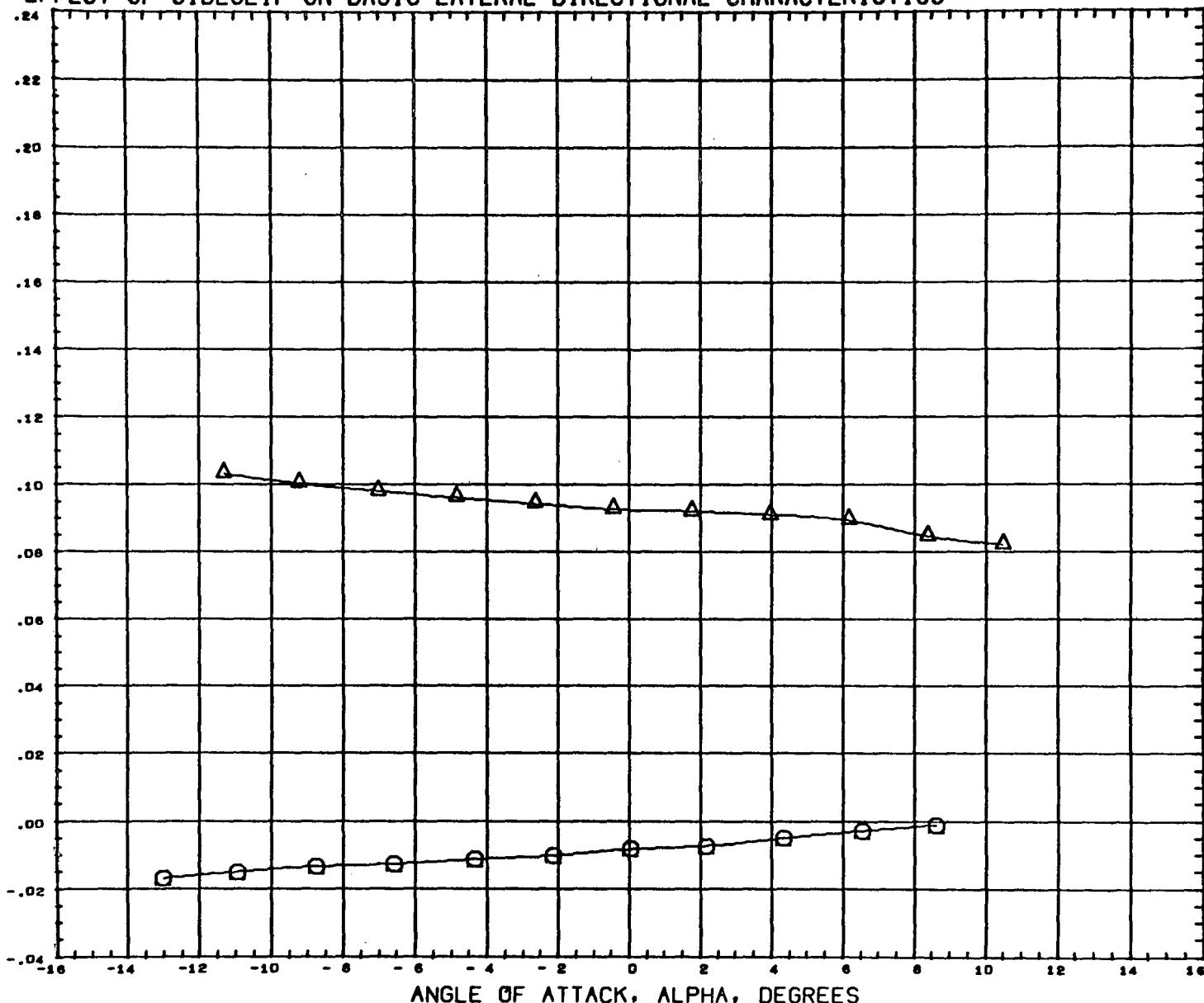
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.901

PAGE 134

## EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5104A) MSFC5D9 NR 11OC ORBITER B14K3W26E16V36  
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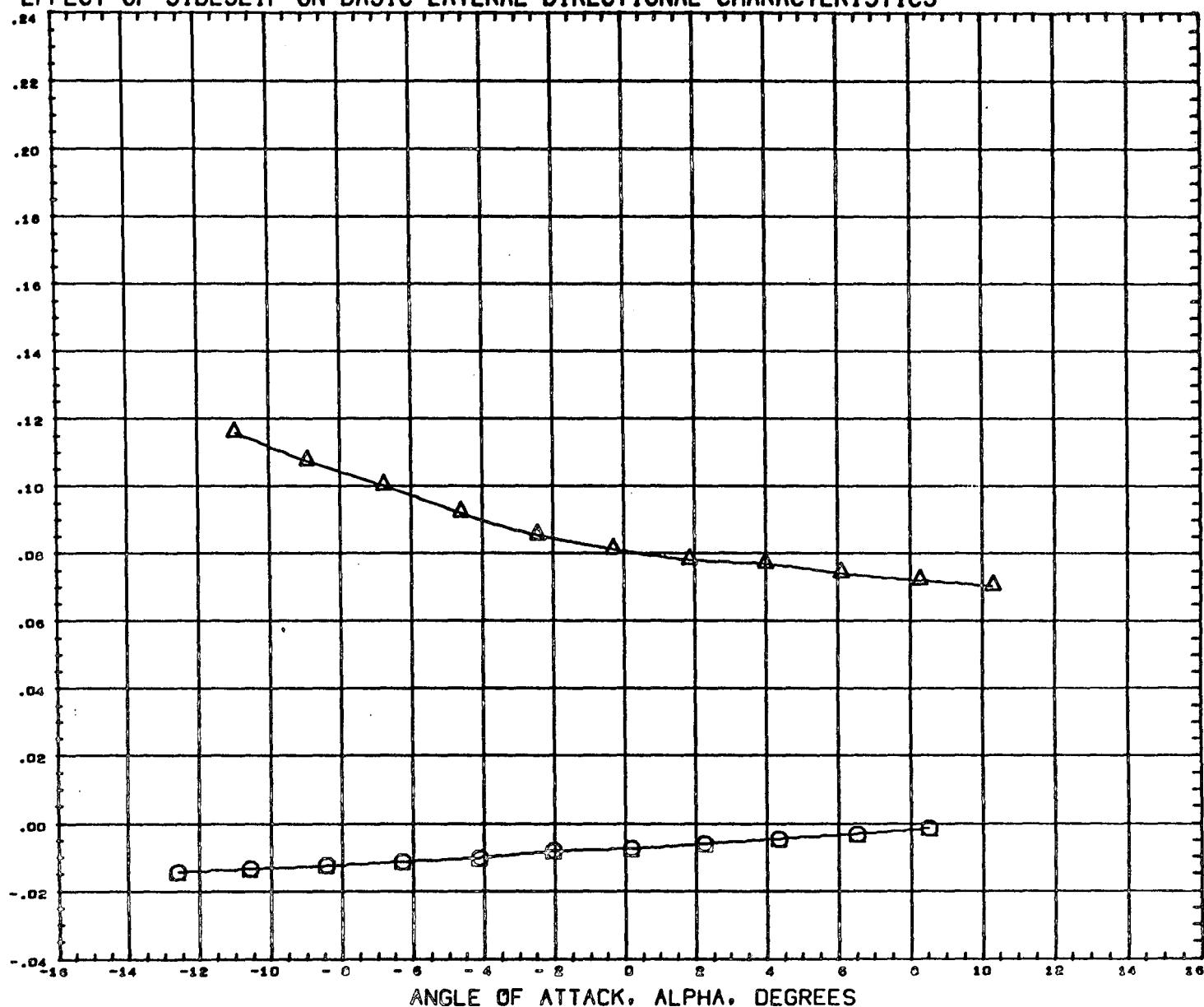
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.195

PAGE 135

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5104A) M8FC509 NR 11OC ORBITER B14K3W26E16V36  
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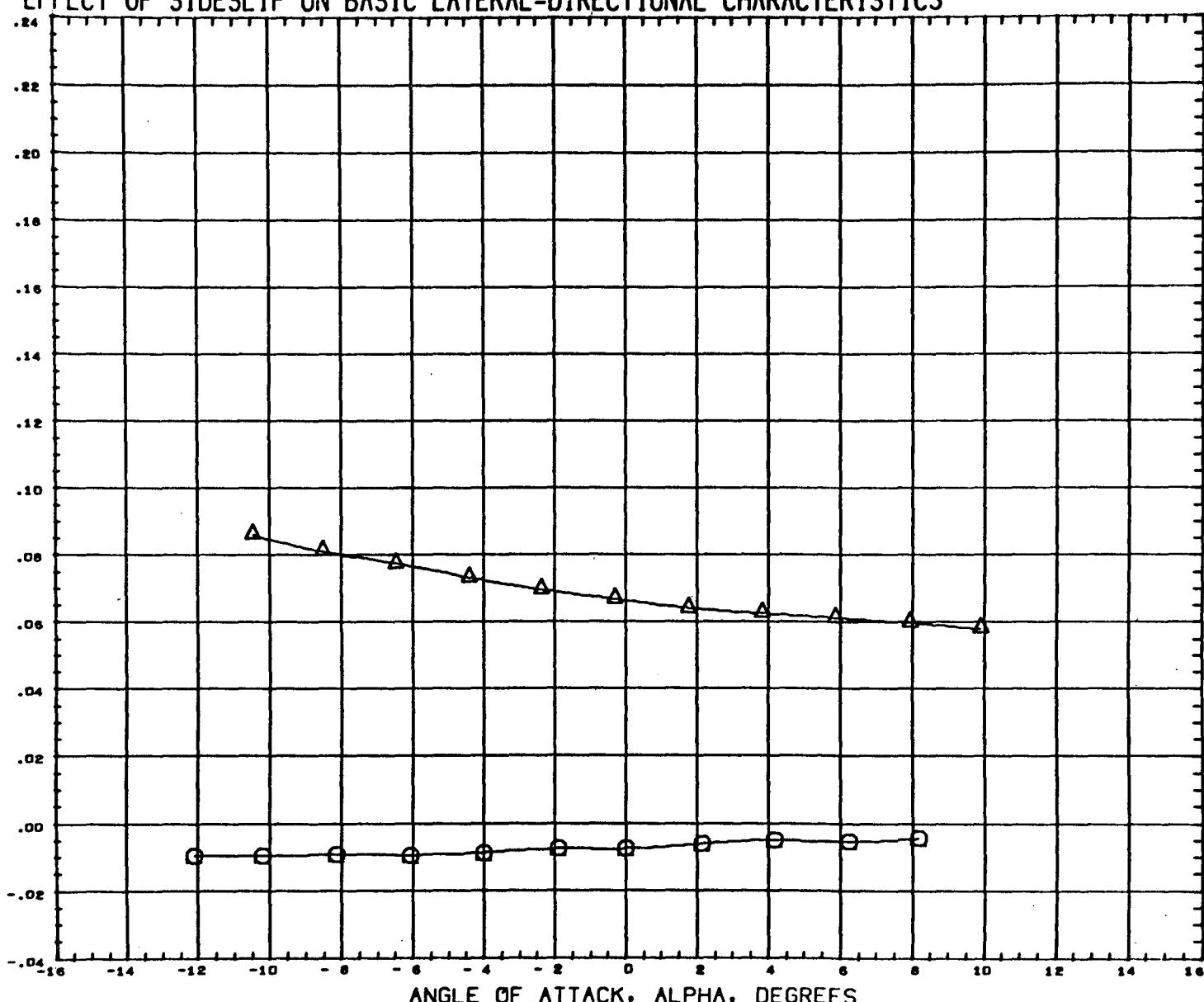
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 ZMRP - 0.099D INCHES  
 SCALE 0.0044 SCALE

MACH 8.096

PAGE 136

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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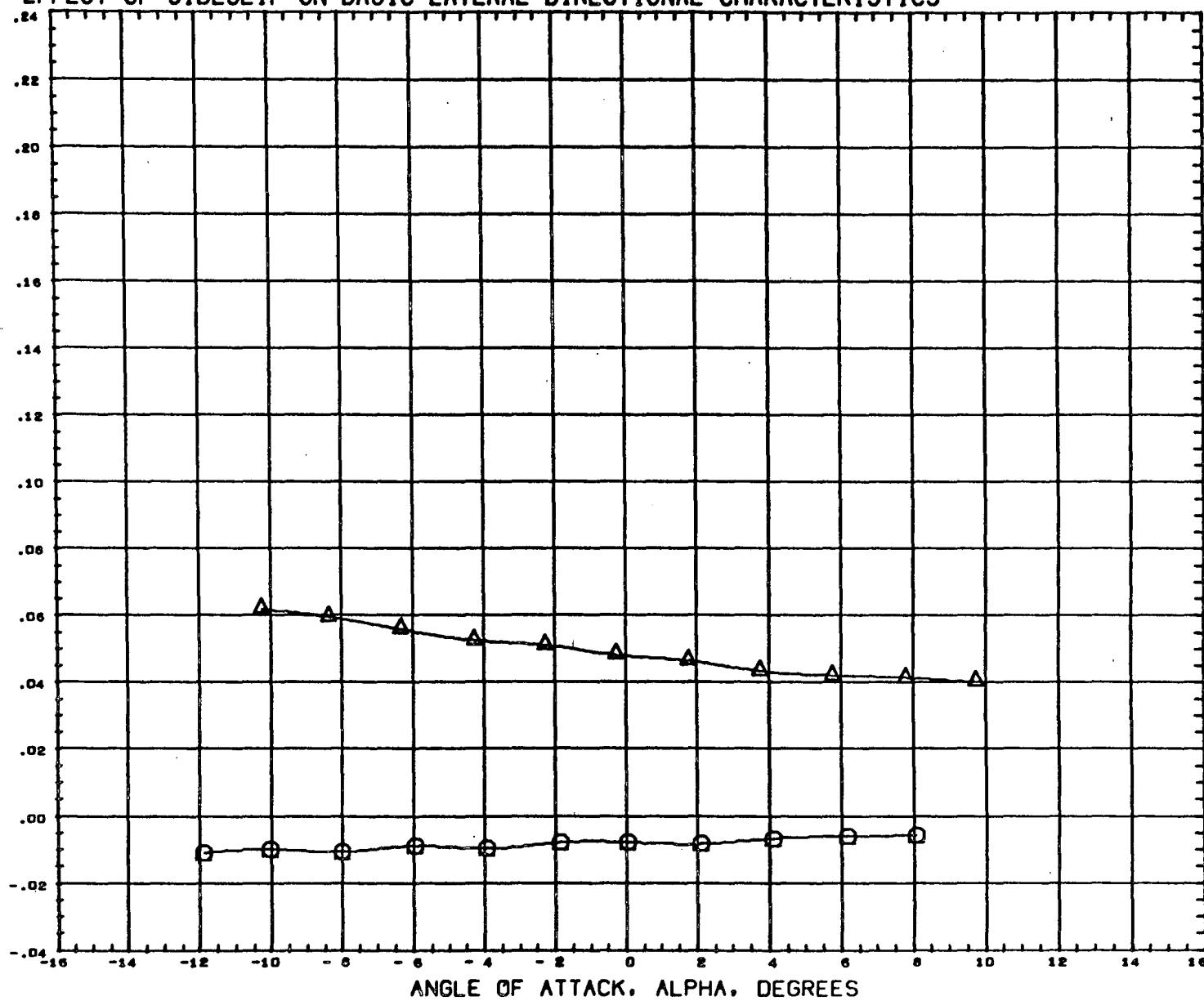
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 SCALE 0.0044 SCALE

MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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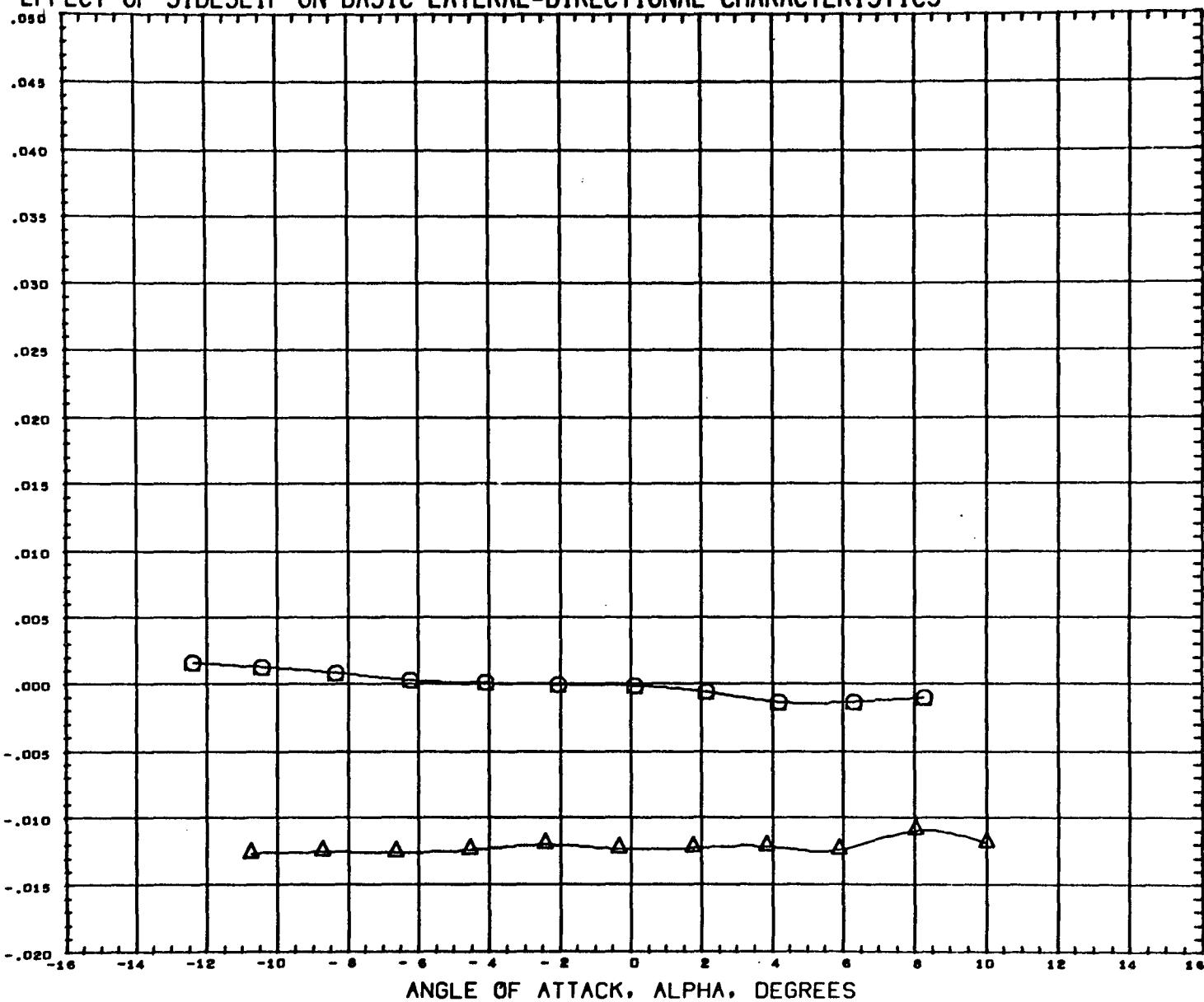
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 SCALE 0.0044 SCALE

MACH 4.959

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# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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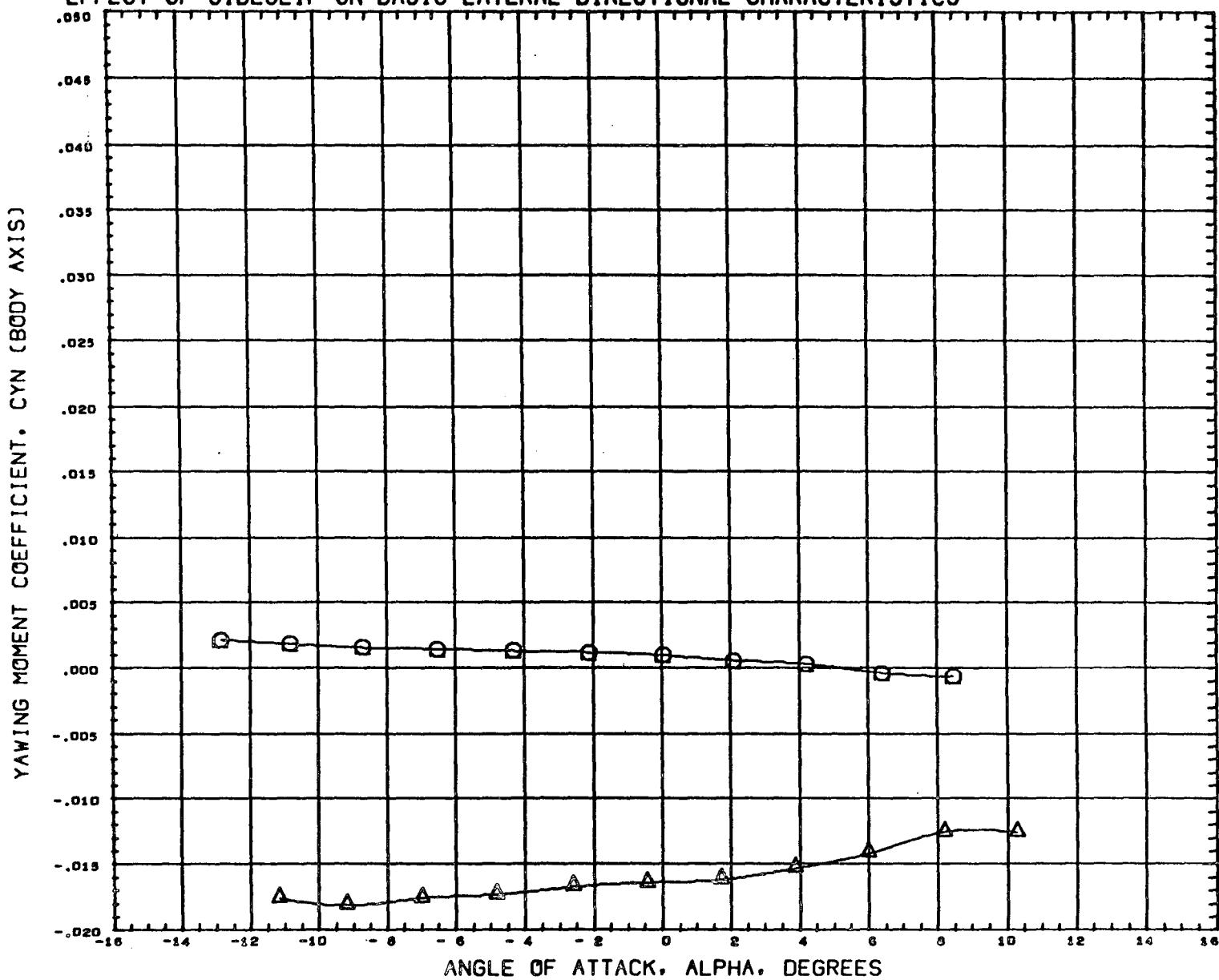
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 SCALE 0.0044 SCALE

MACH 0.601

PAGE 139

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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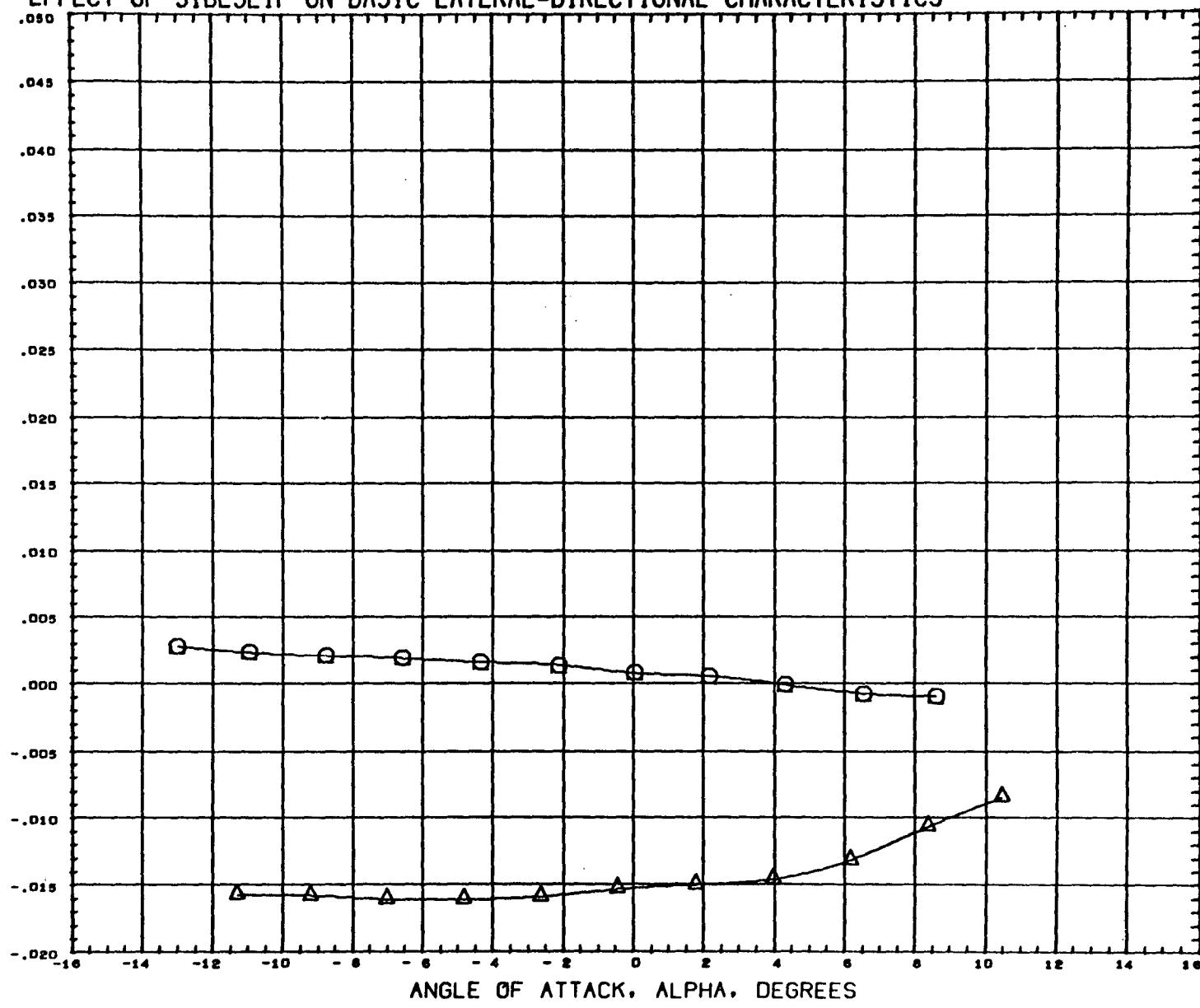
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MACH 0.901

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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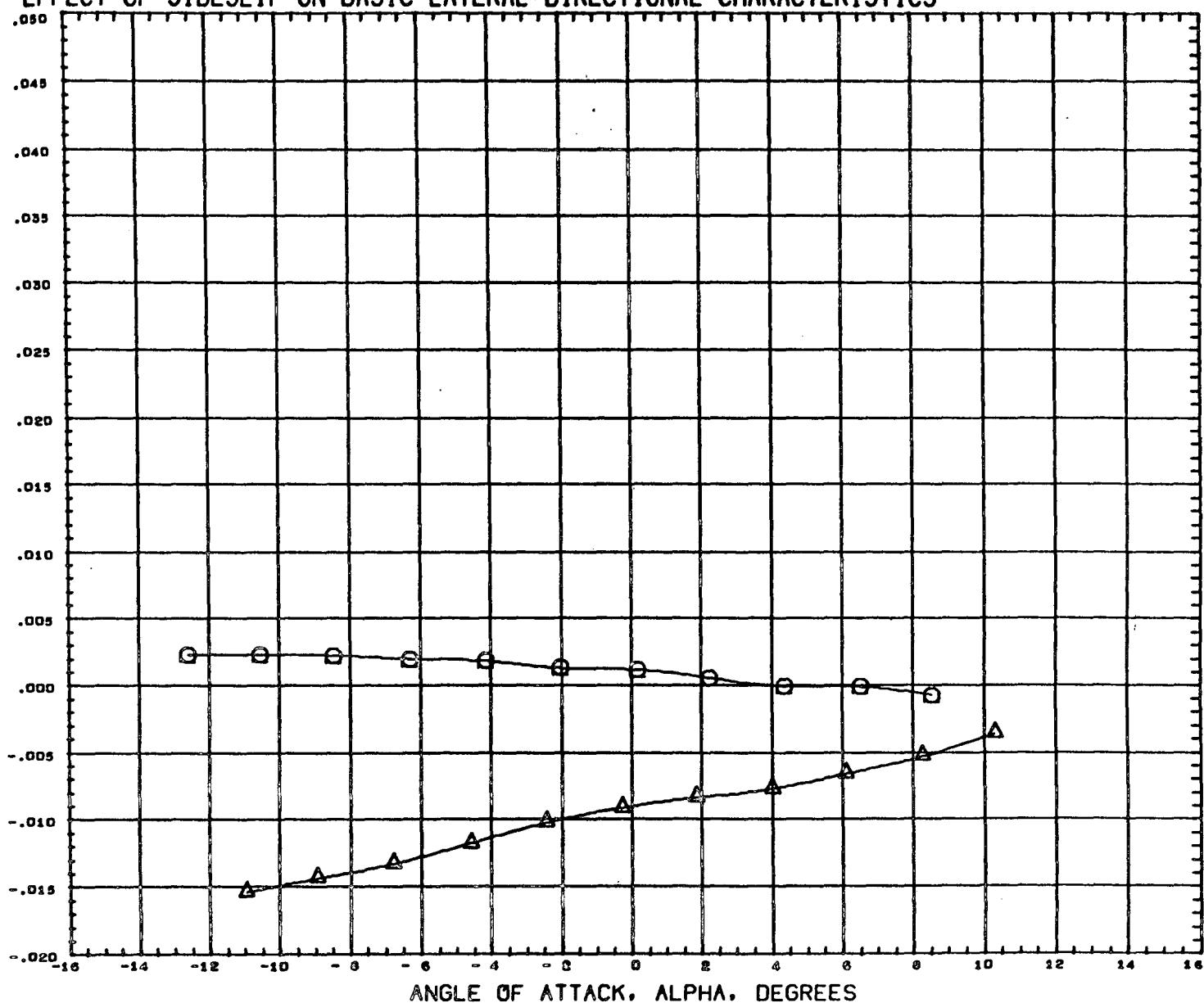
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 SCALE 0.0044 SCALE

MACH 1.195

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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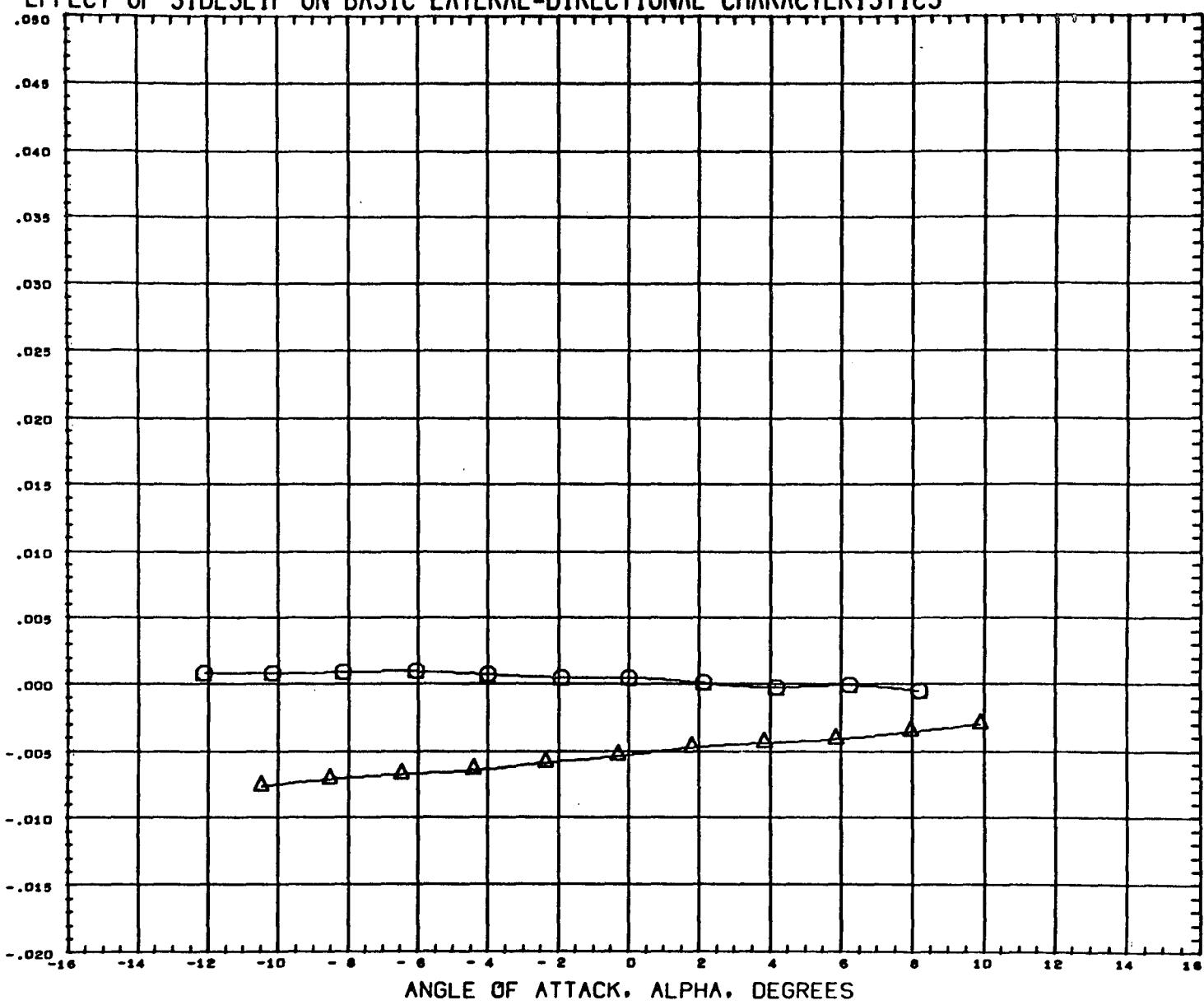
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 SCALE 0.0044 SCALE

MACH 0.936

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## EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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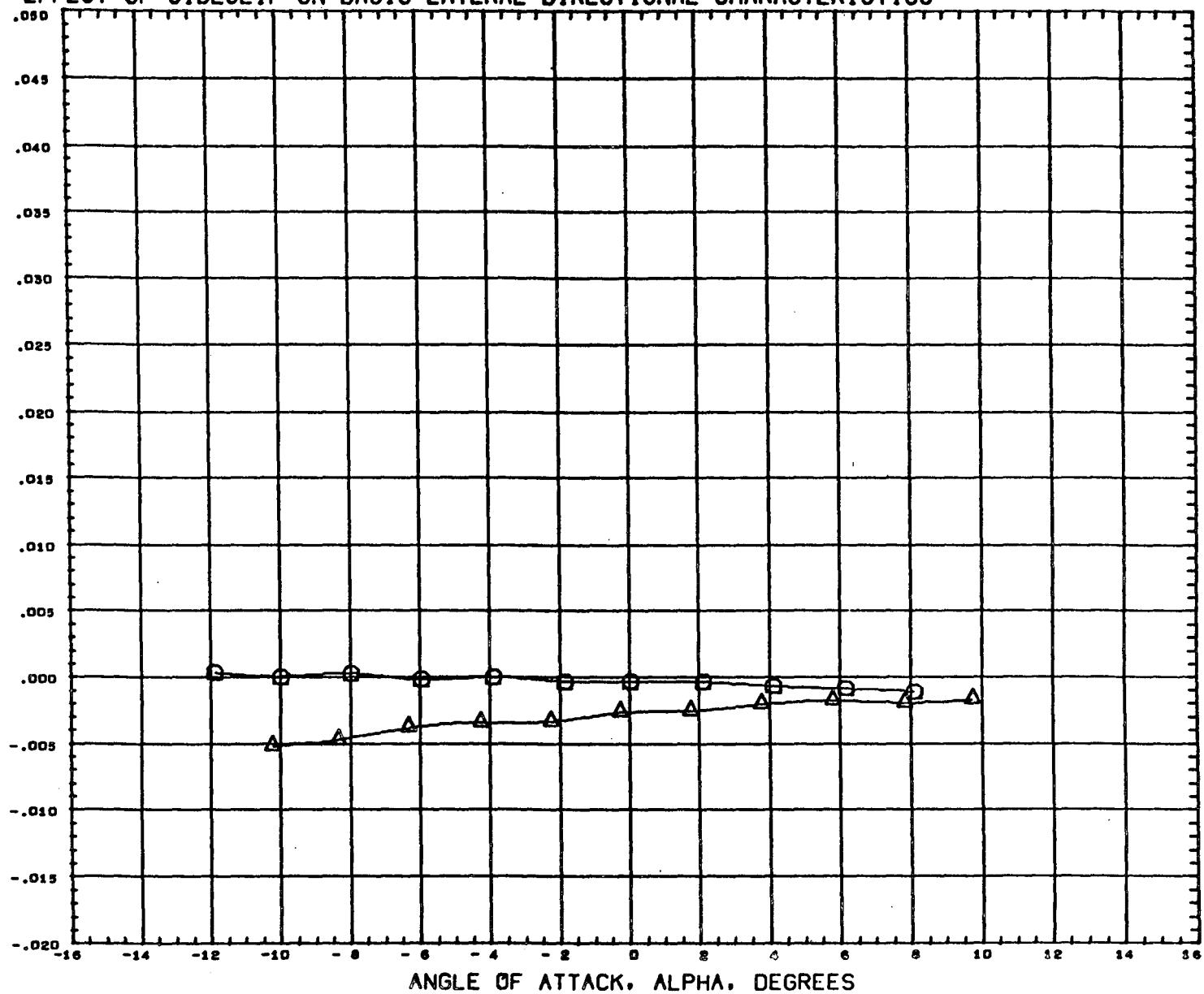
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 SCALE 0.0044 SCALE

MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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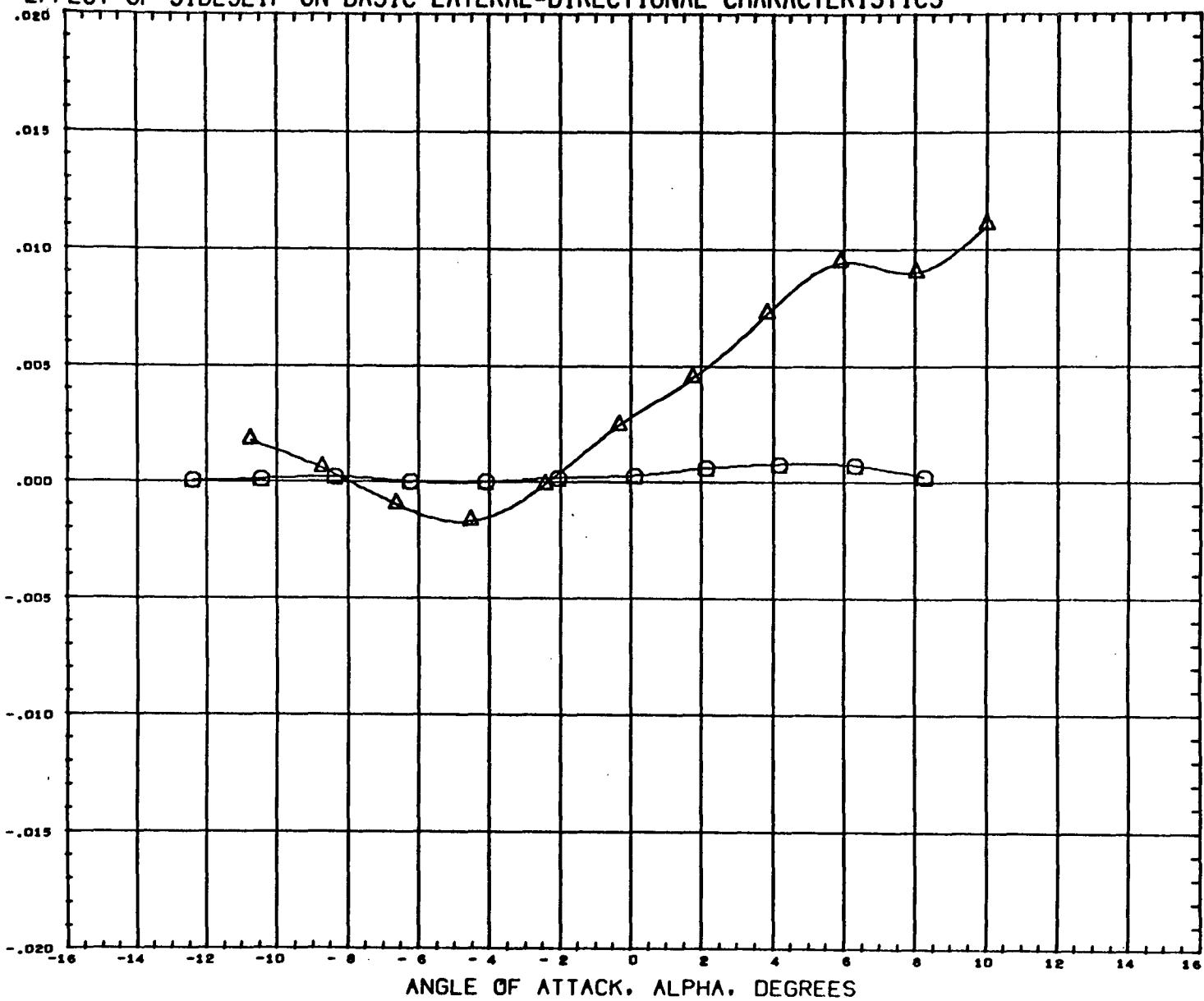
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 4.959

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# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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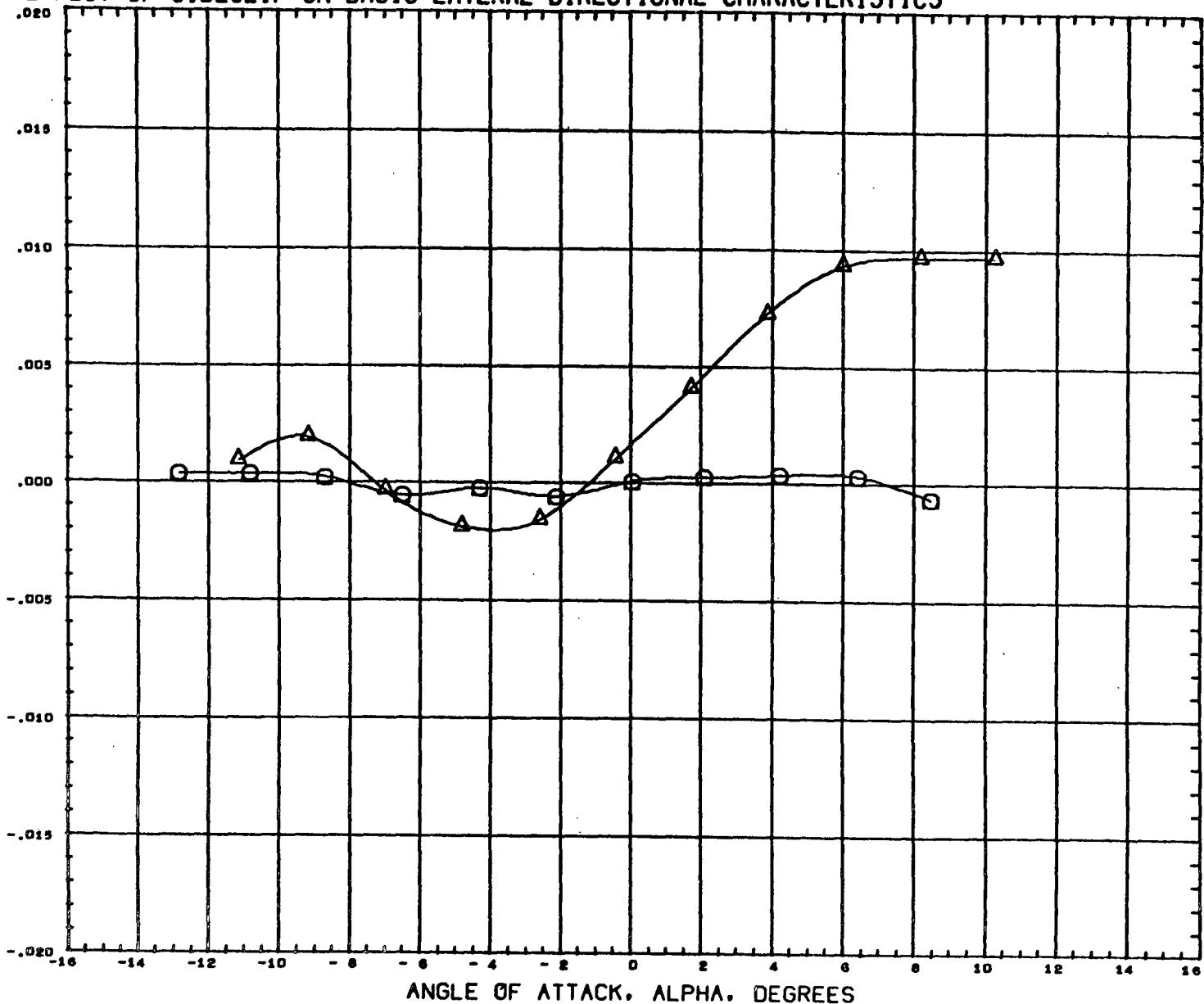
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MACH 0.601

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT. CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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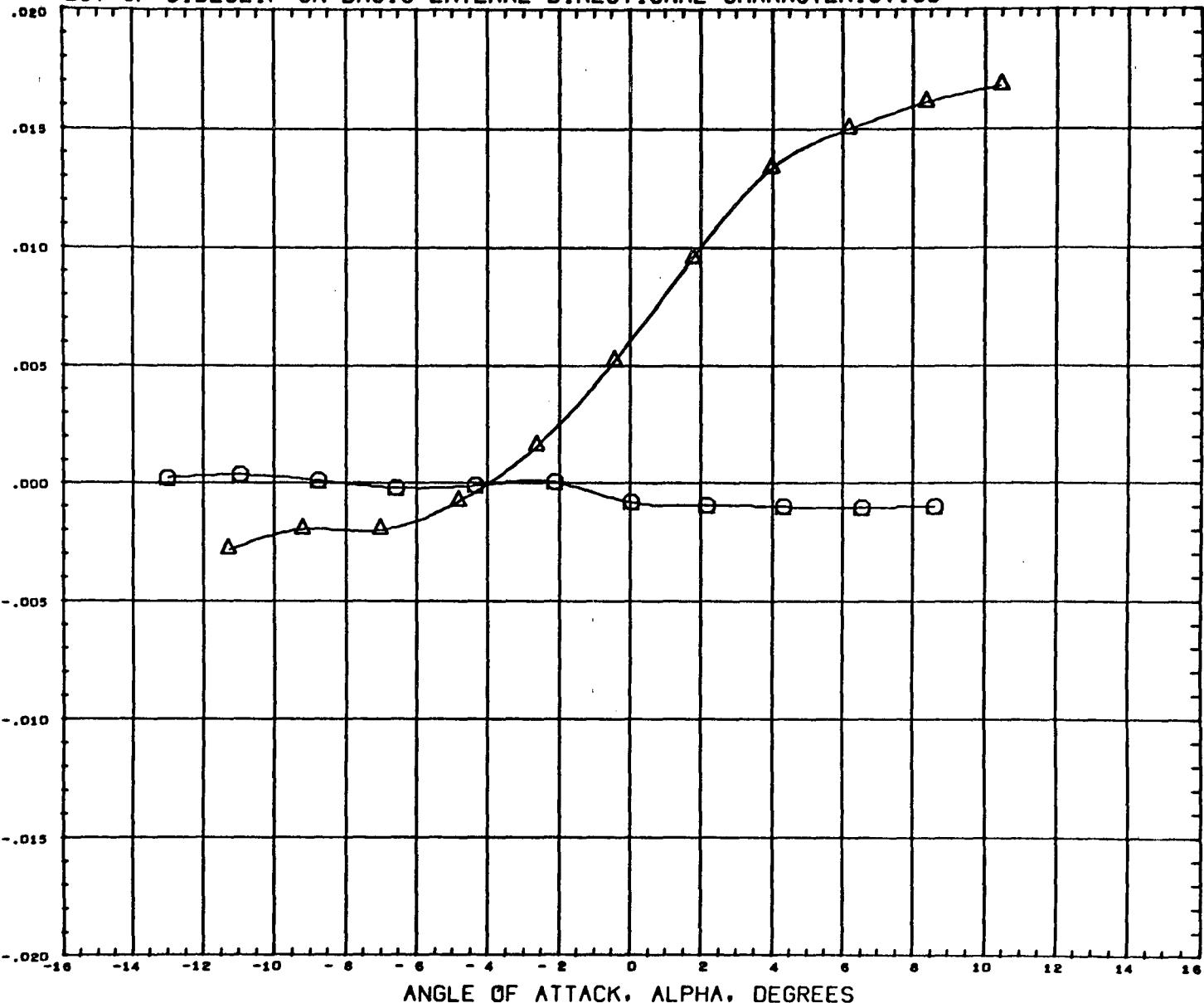
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MACH 0.901

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT. CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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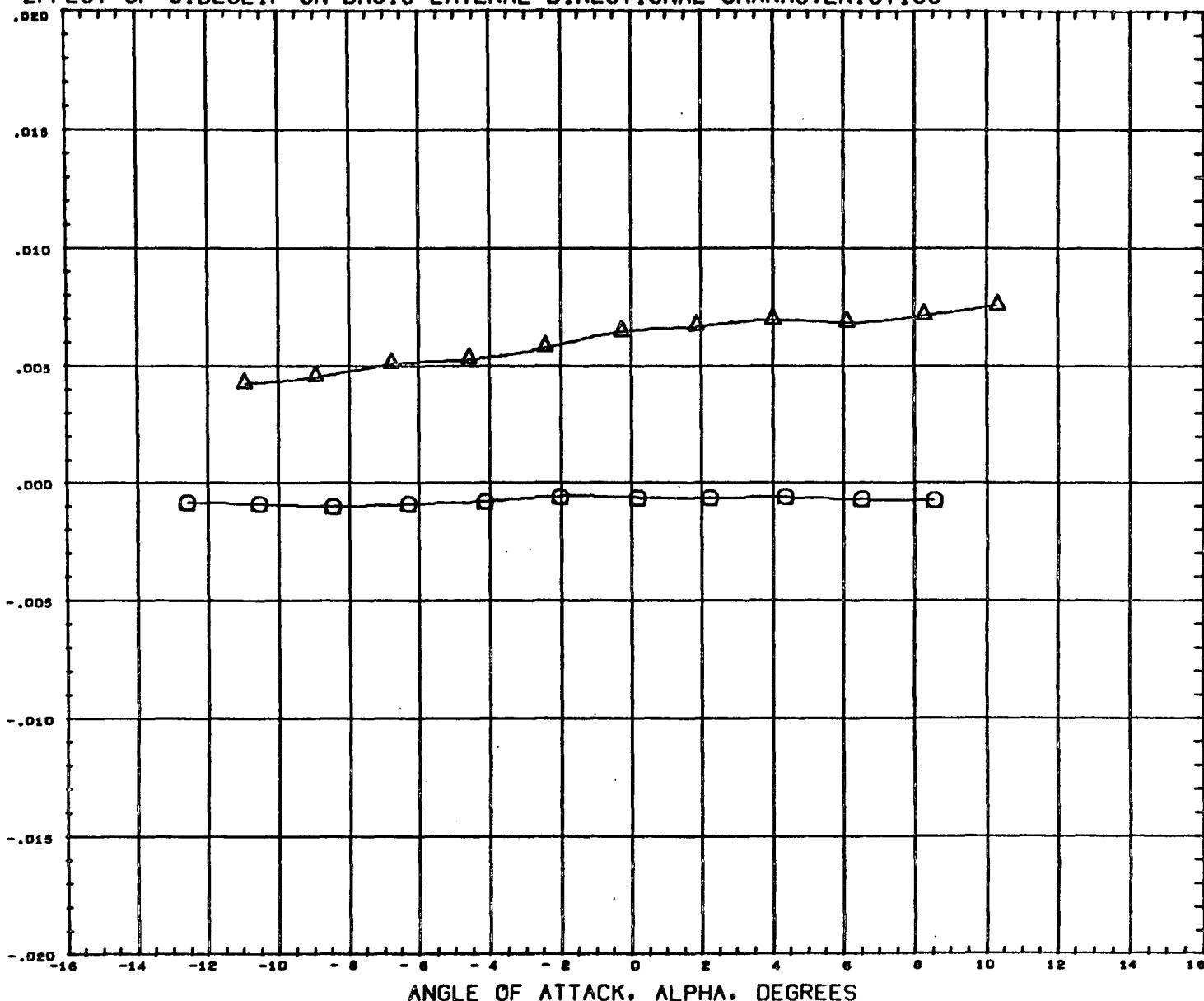
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MACH 2.195

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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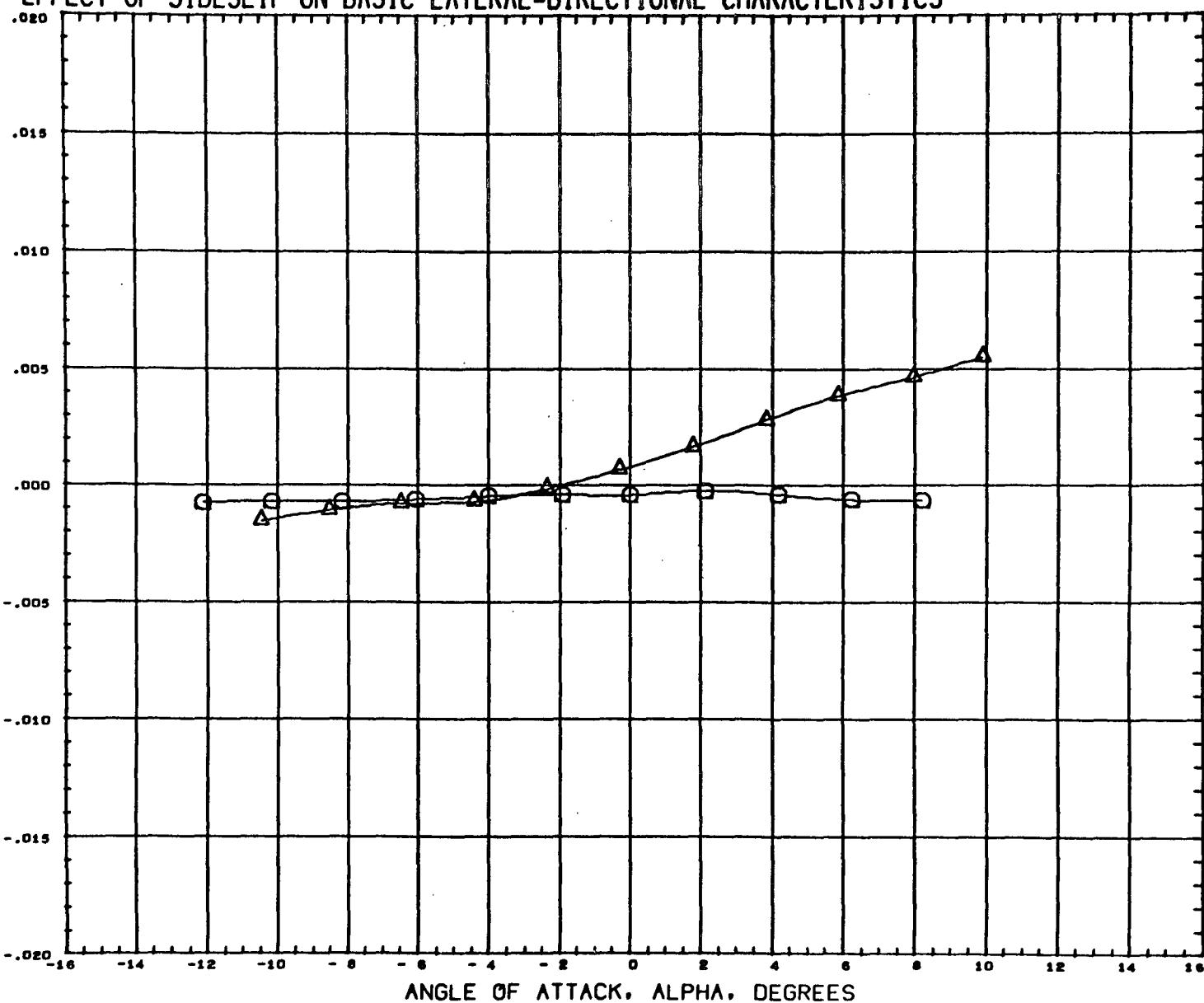
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 SCALE 0.0044 SCALE

MACH 2.056

PAGE 148

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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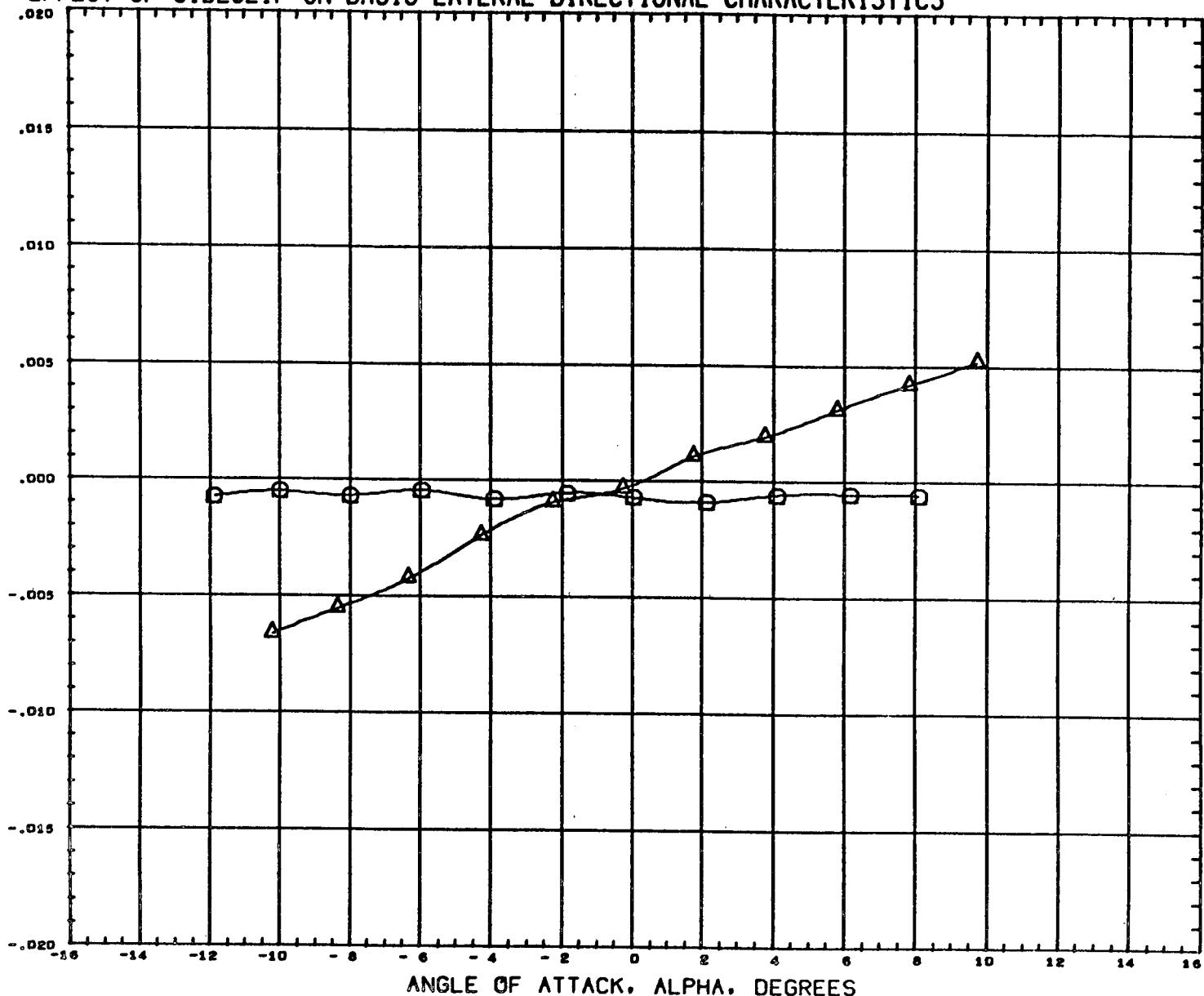
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MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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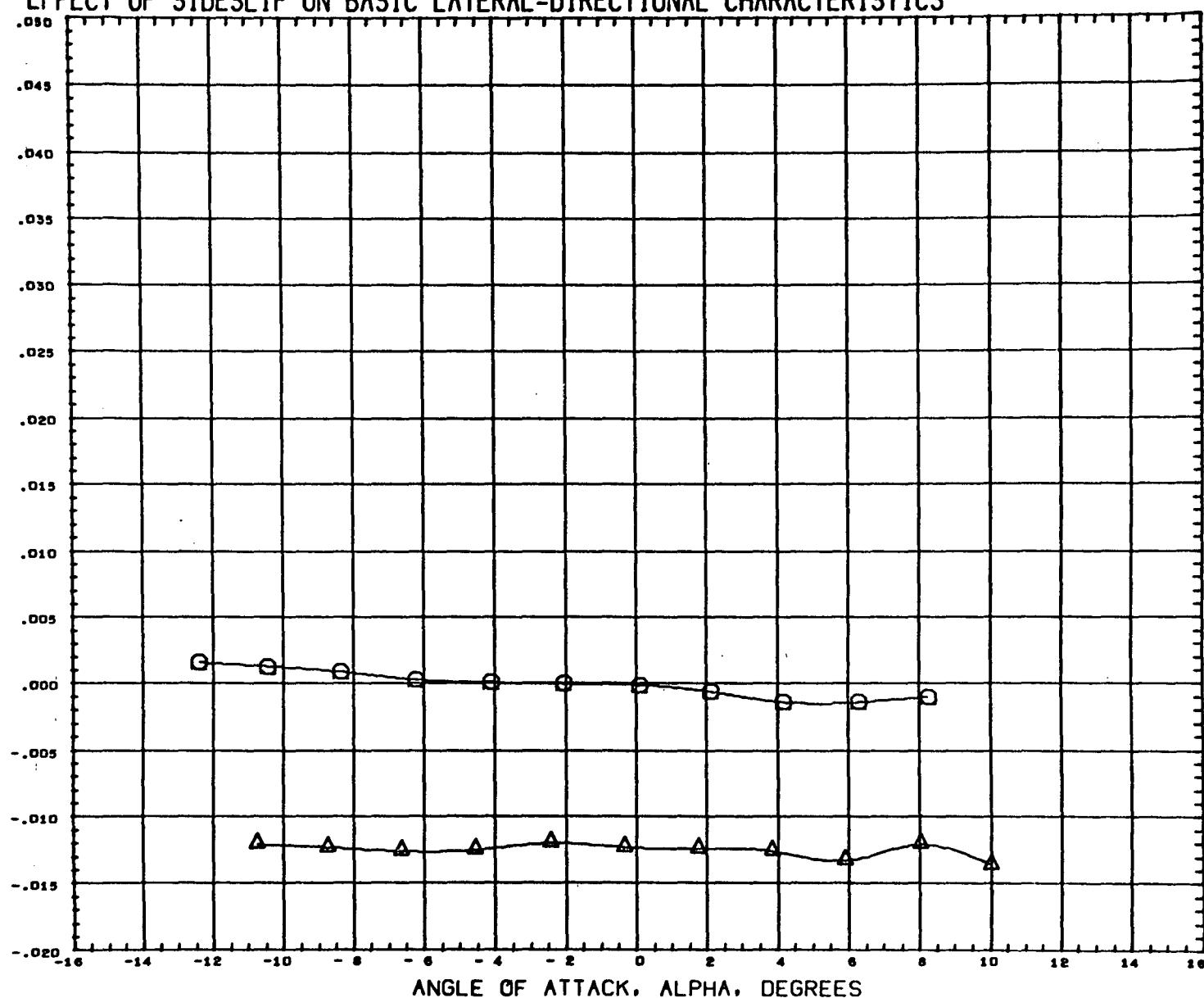
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MACH 4.859

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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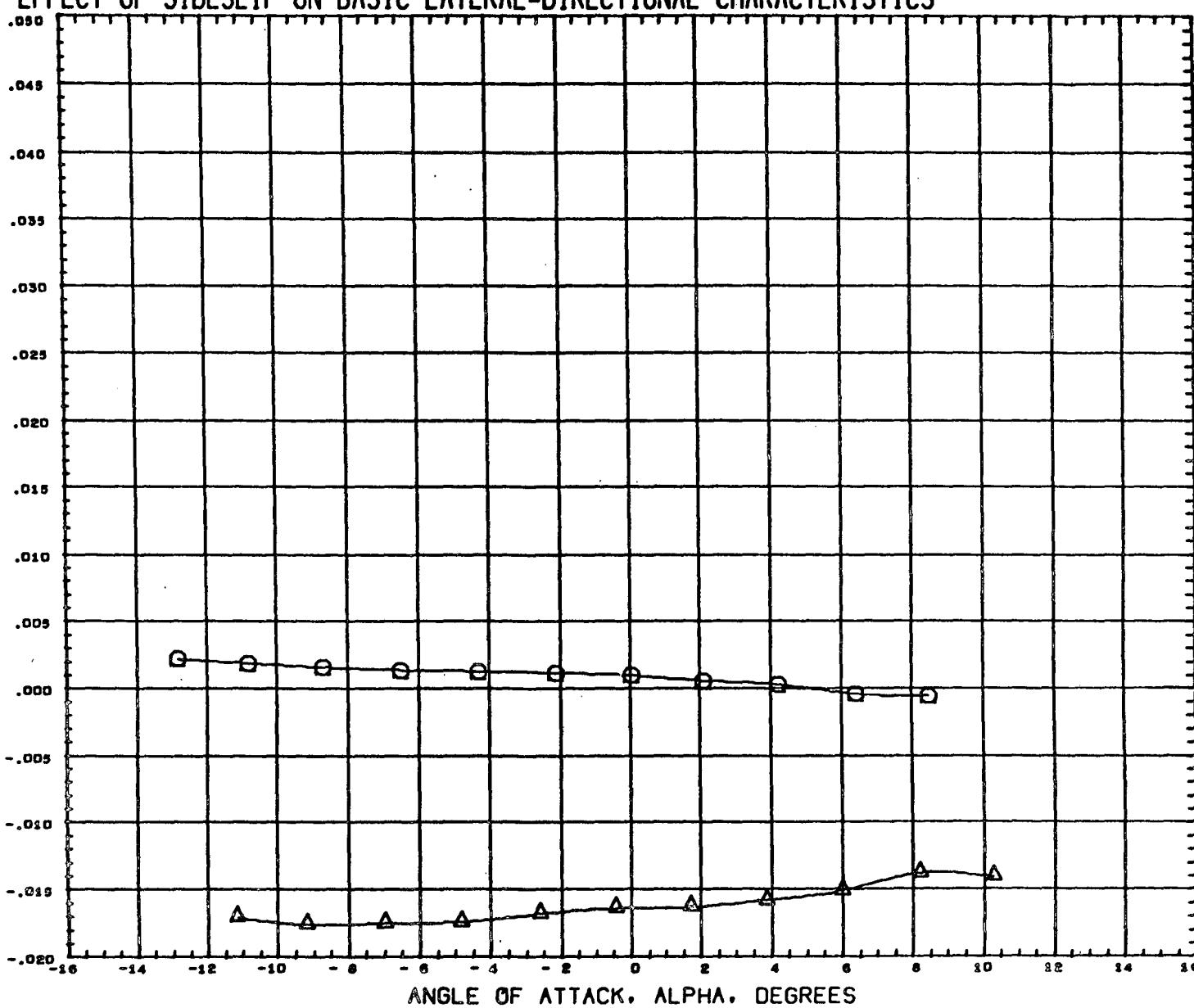
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MACH 0.601

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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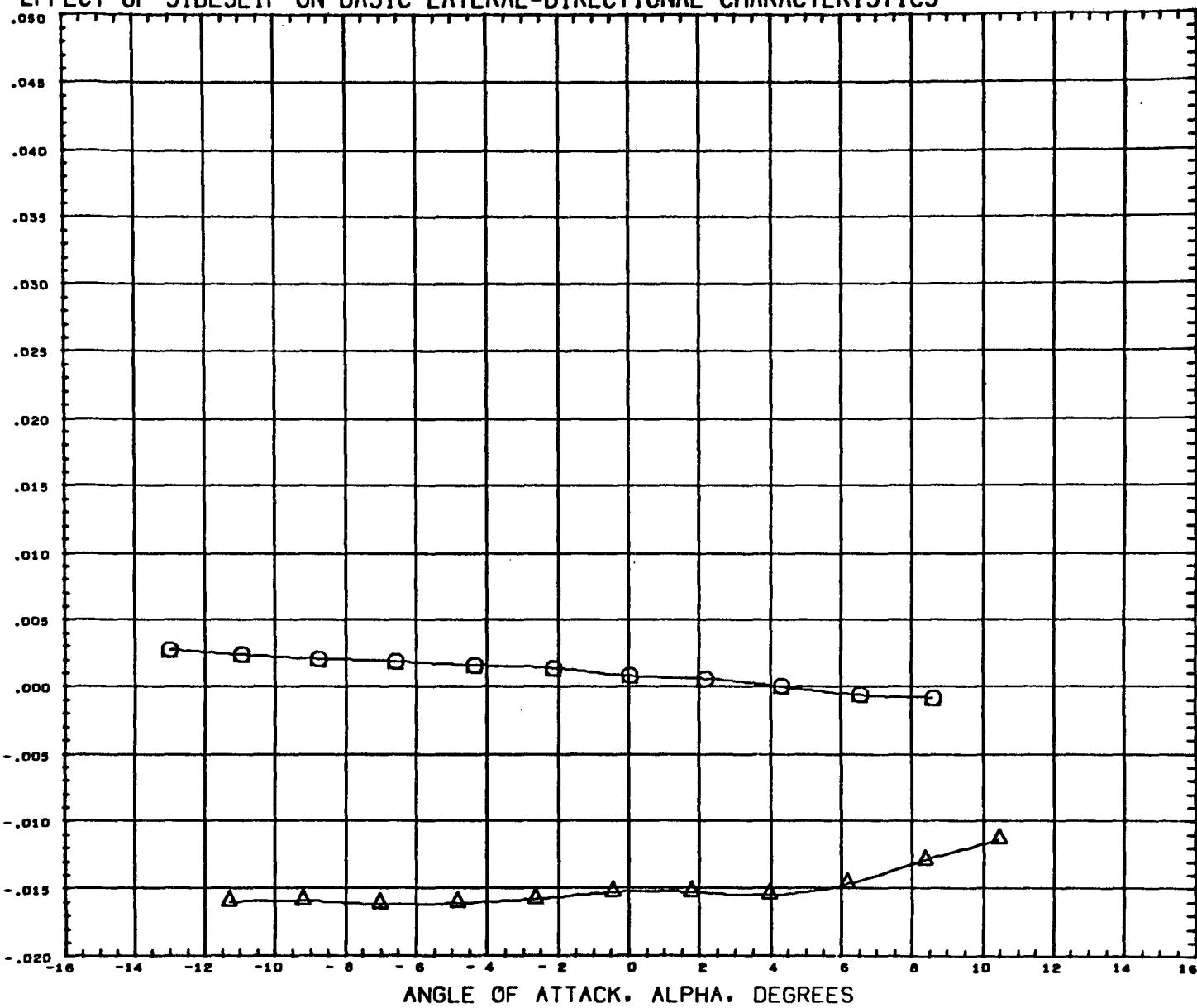
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 SCALE 0.0044 SCALE

MACH 0.902

PAGE 152

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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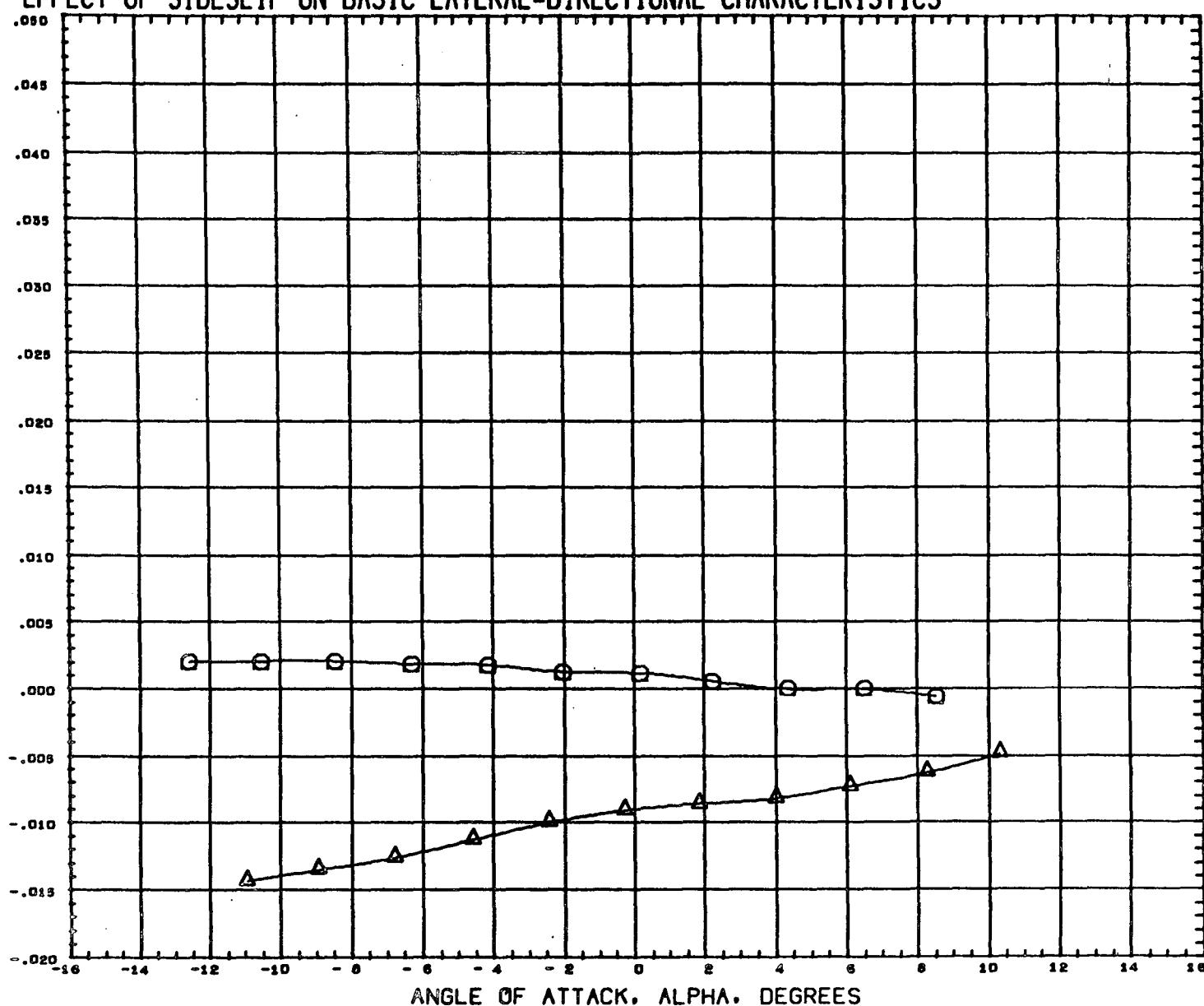
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MACH 1.195

PAGE 153

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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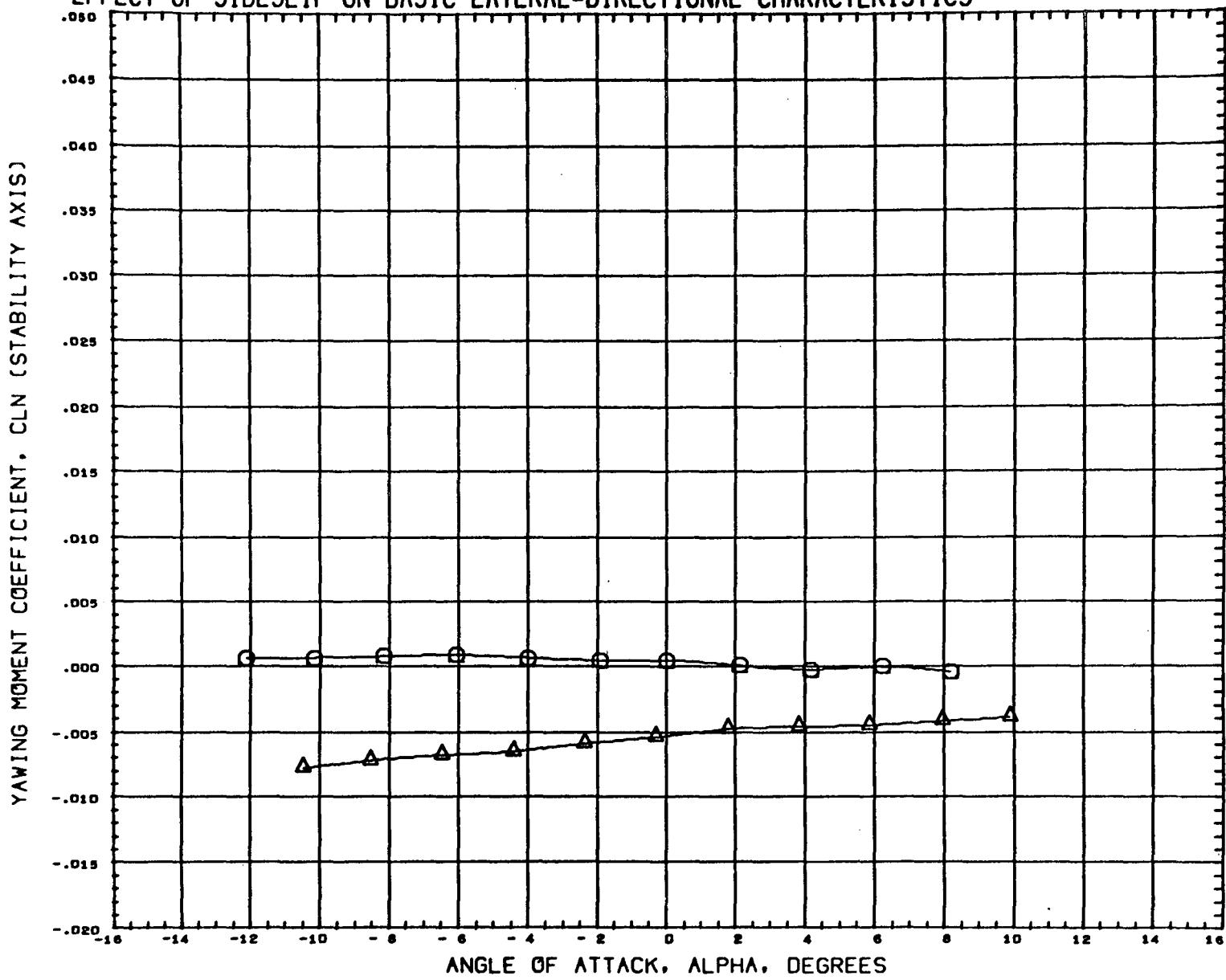
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 SCALE 0.0044 SCALE

MACH 8.056

PAGE 154

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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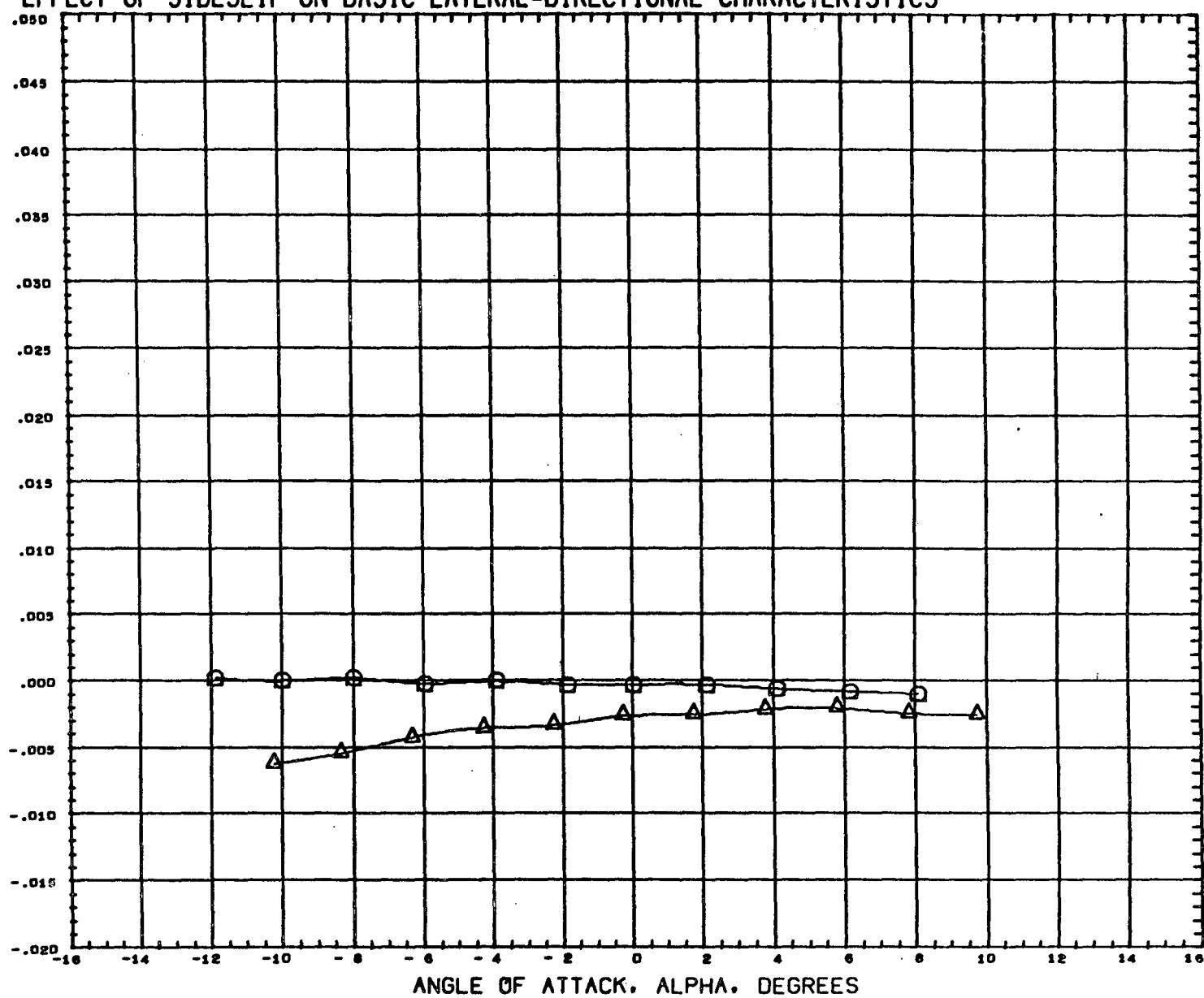
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MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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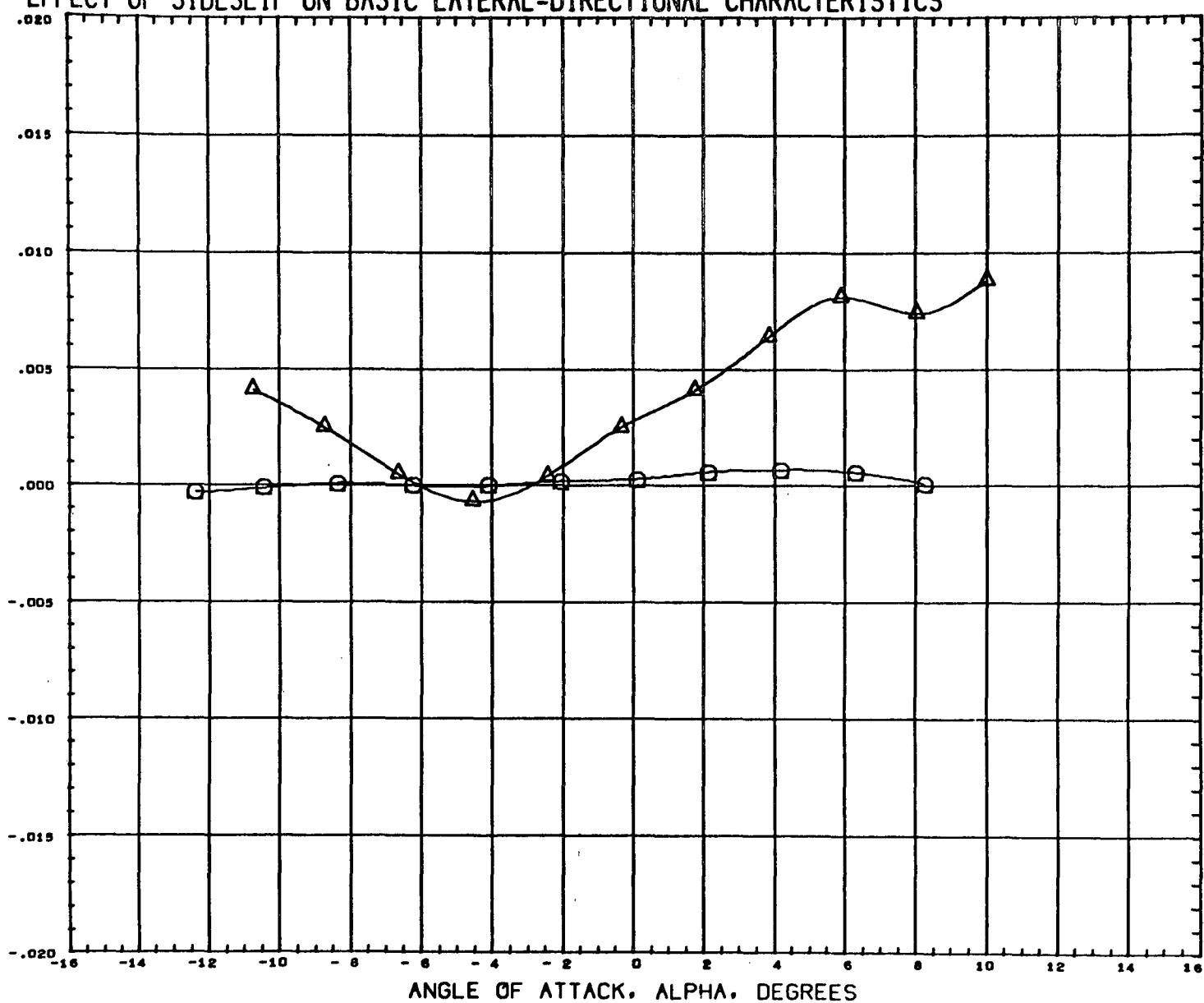
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 SCALE 0.0044 SCALE

MACH 4.959

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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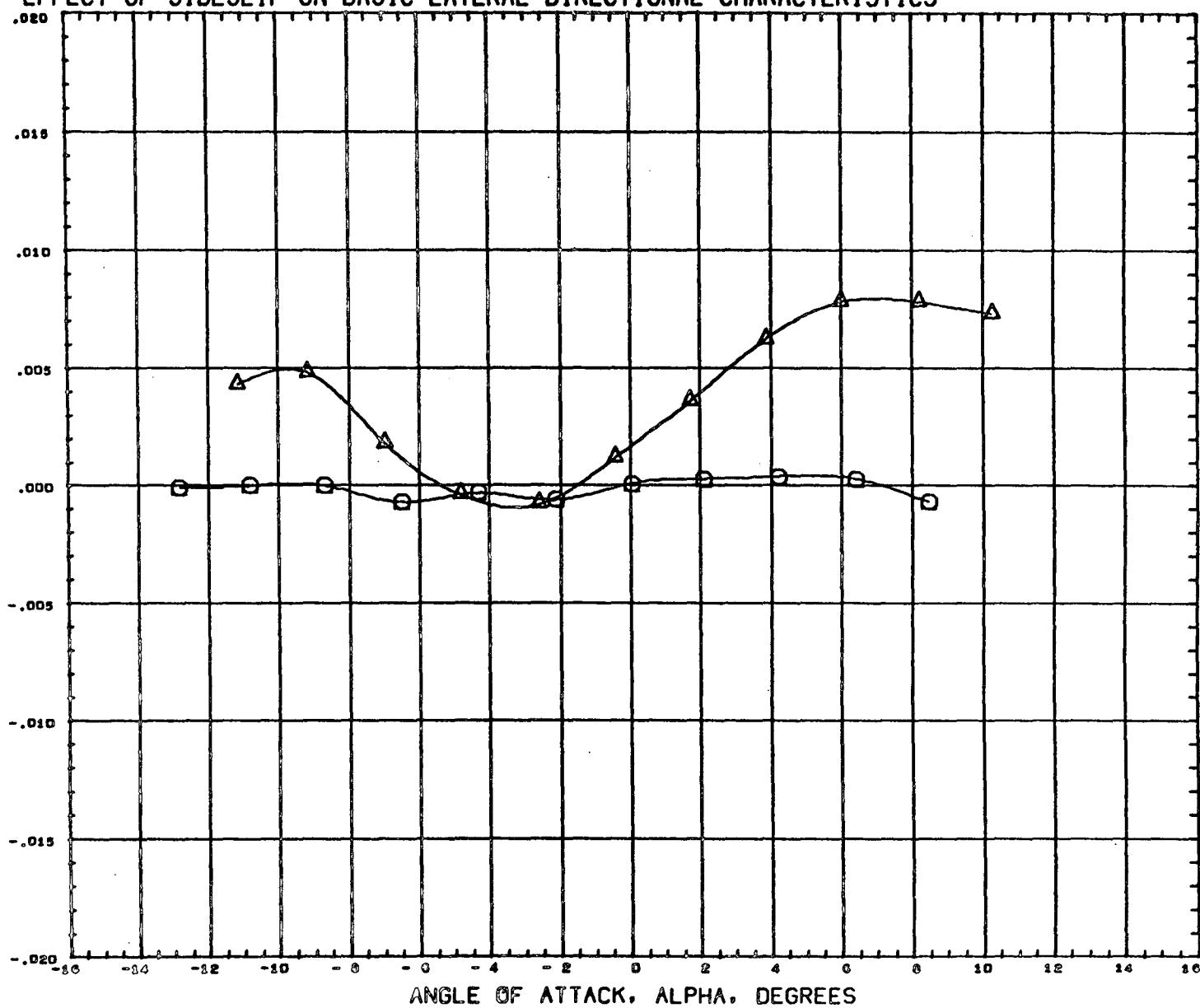
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 SCALE 0.0044 SCALE

MACH 0.601

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT. CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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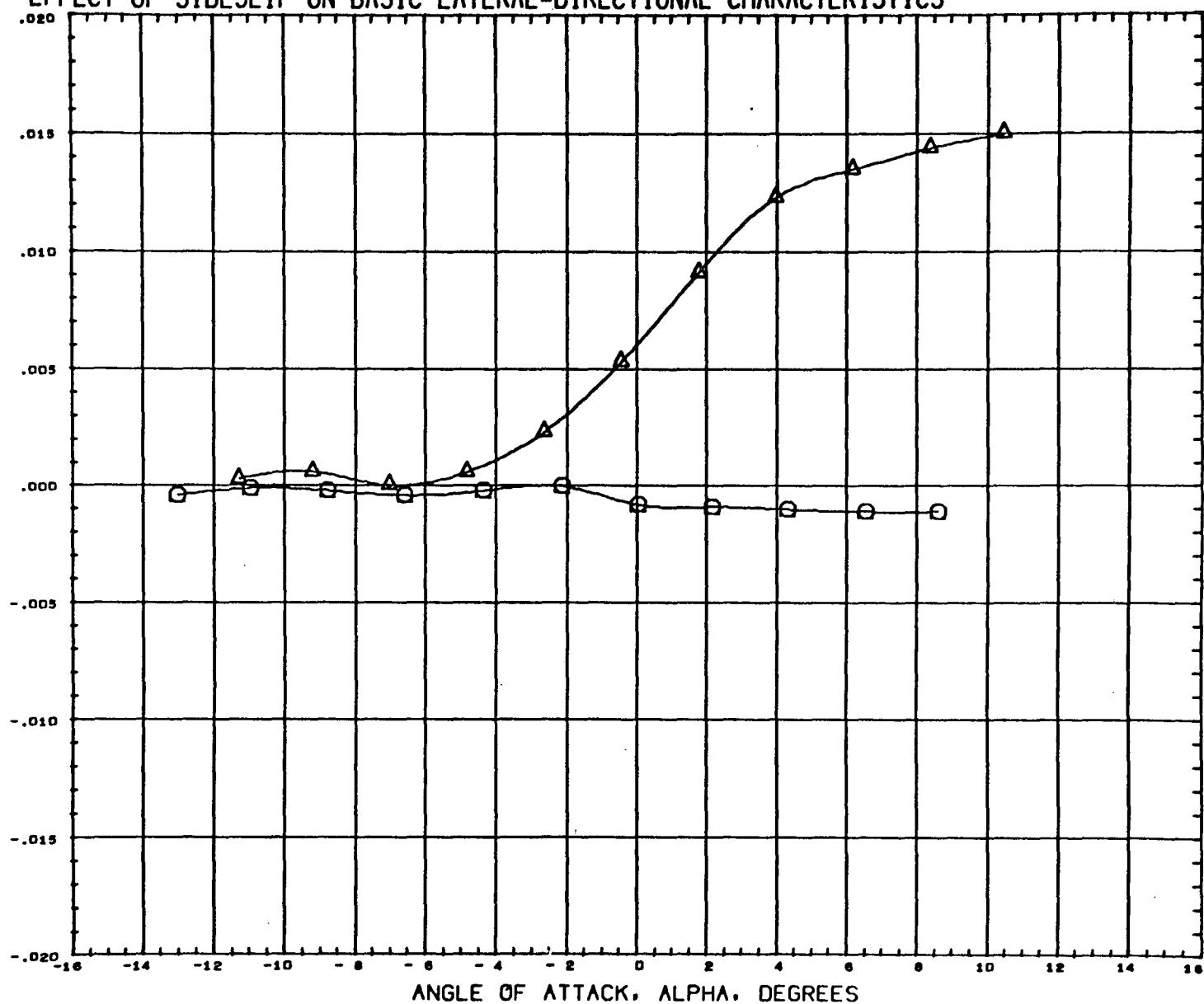
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 SCALE 0.0044 SCALE

MACH 0.901

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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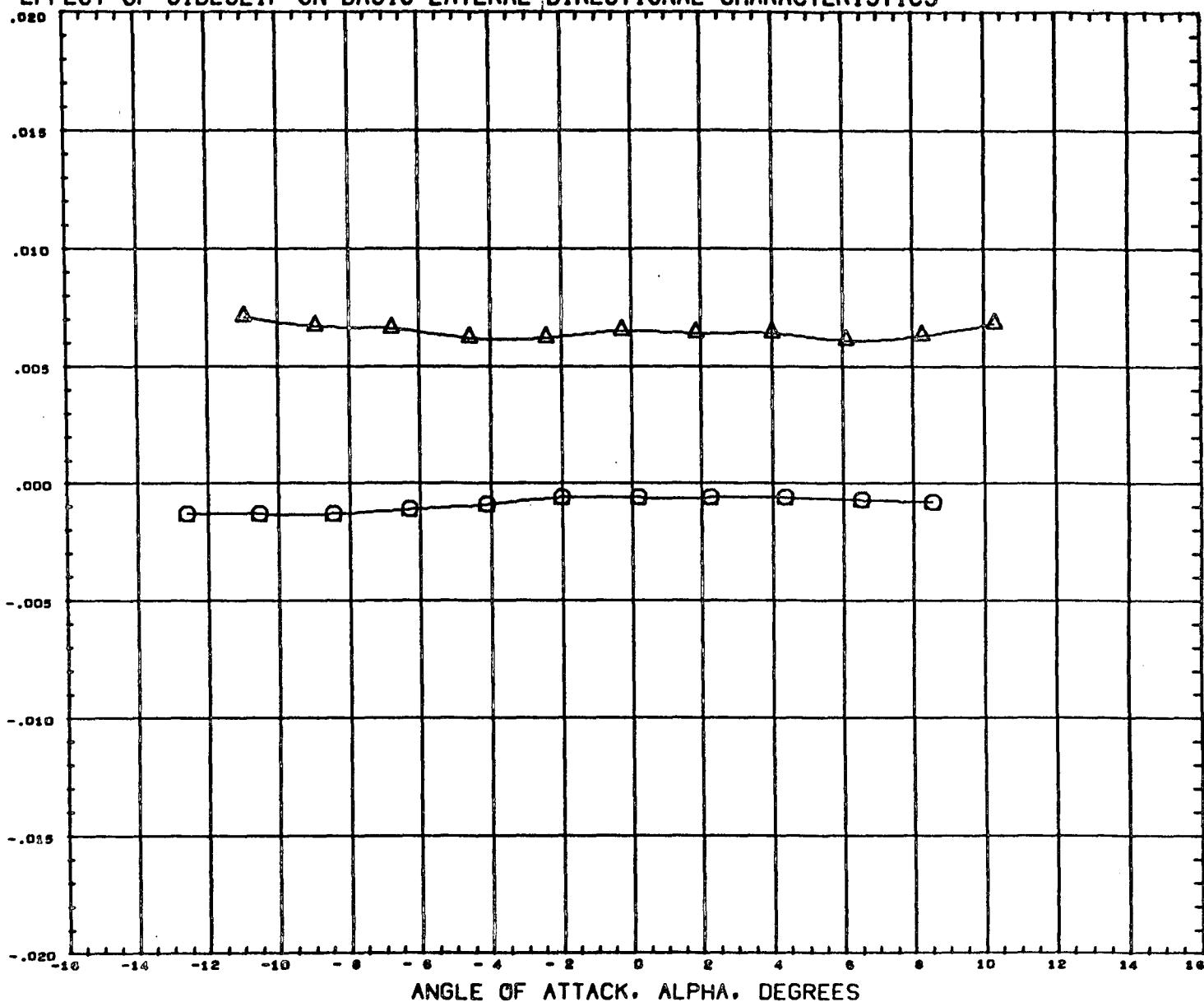
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 SCALE 0.0044 SCALE

MACH 1.195

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# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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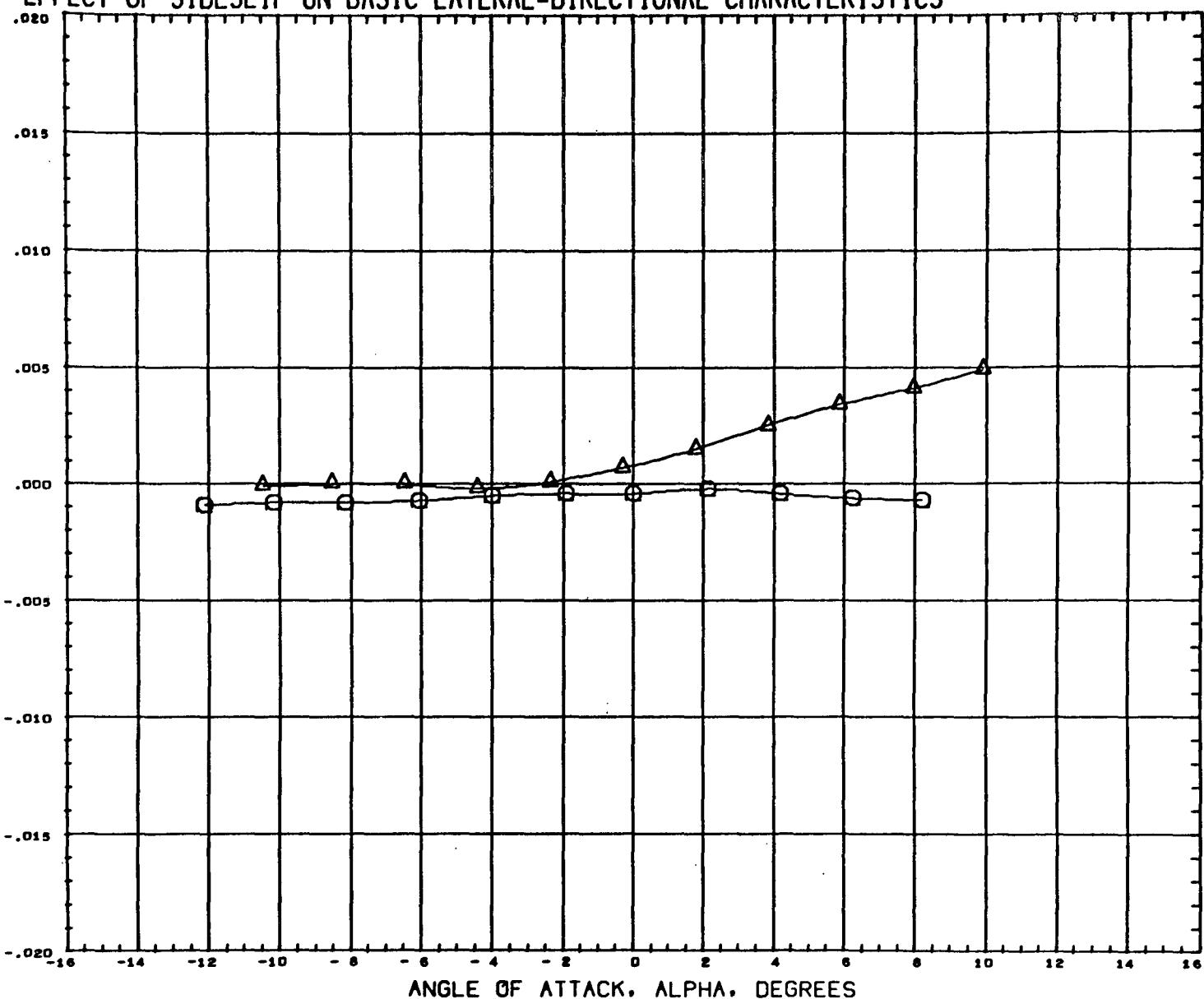
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.050

PAGE 160

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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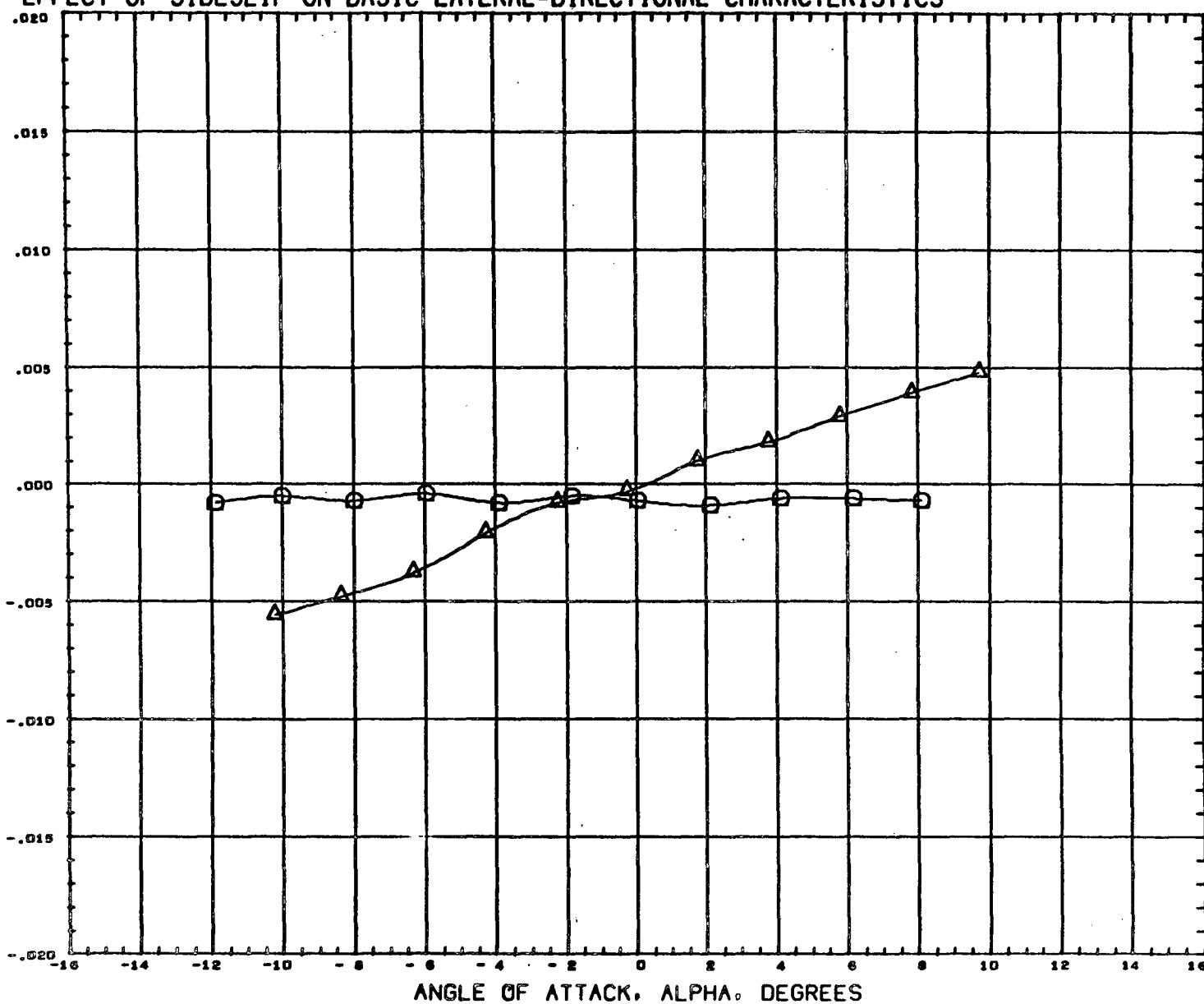
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MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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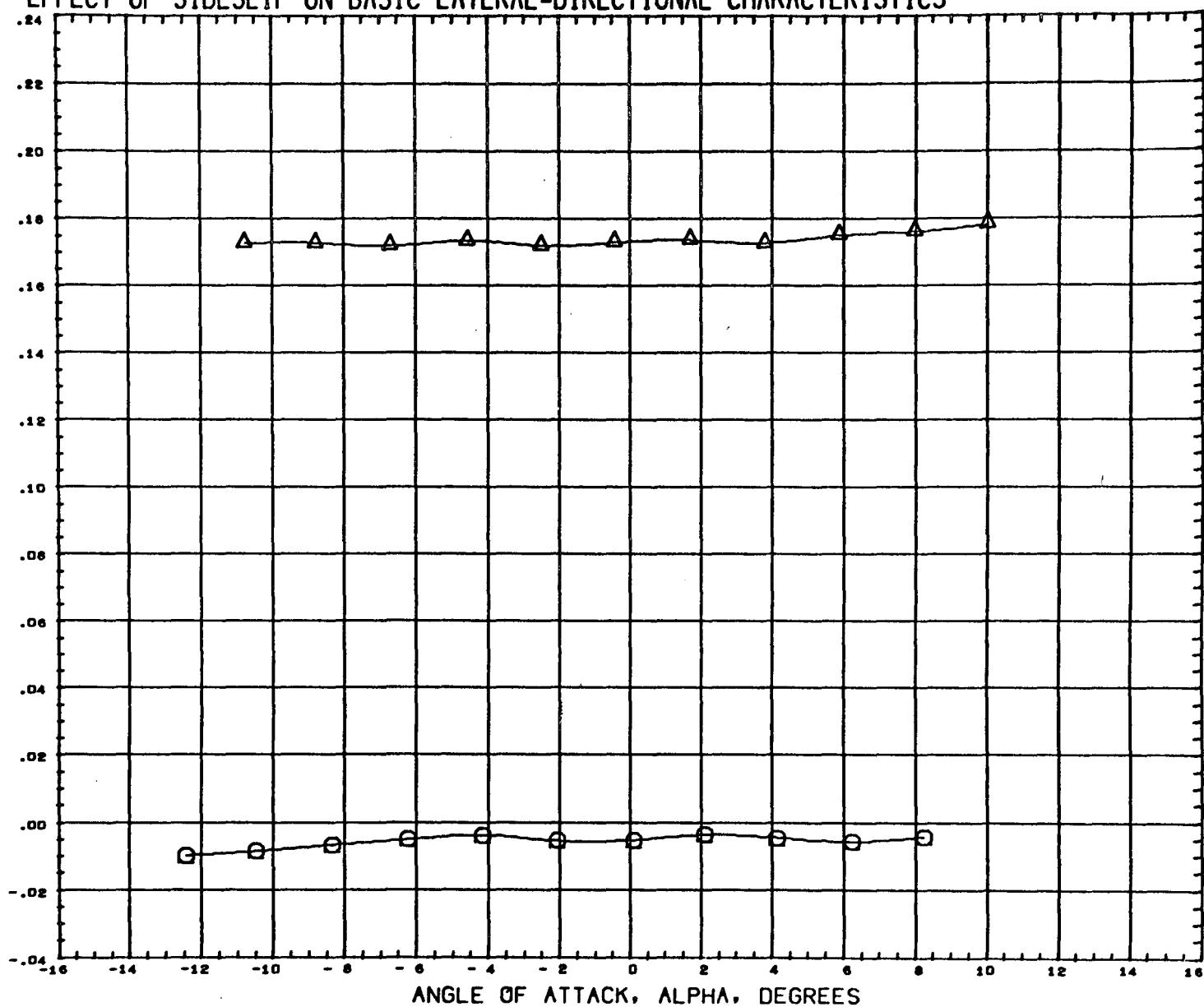
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 YMRP 0.0000 INCHES  
 ZMRP - 0.0990 INCHES  
 BSCALE 0.0044 BSCALE

MACH 4.089

PAGE 162

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5107A) M8FC509 NR 110C ORBITER + TANK B12W26E16V36  
 (B5108A) M8FC509 NR 110C ORBITER + TANK B12W26E16V36

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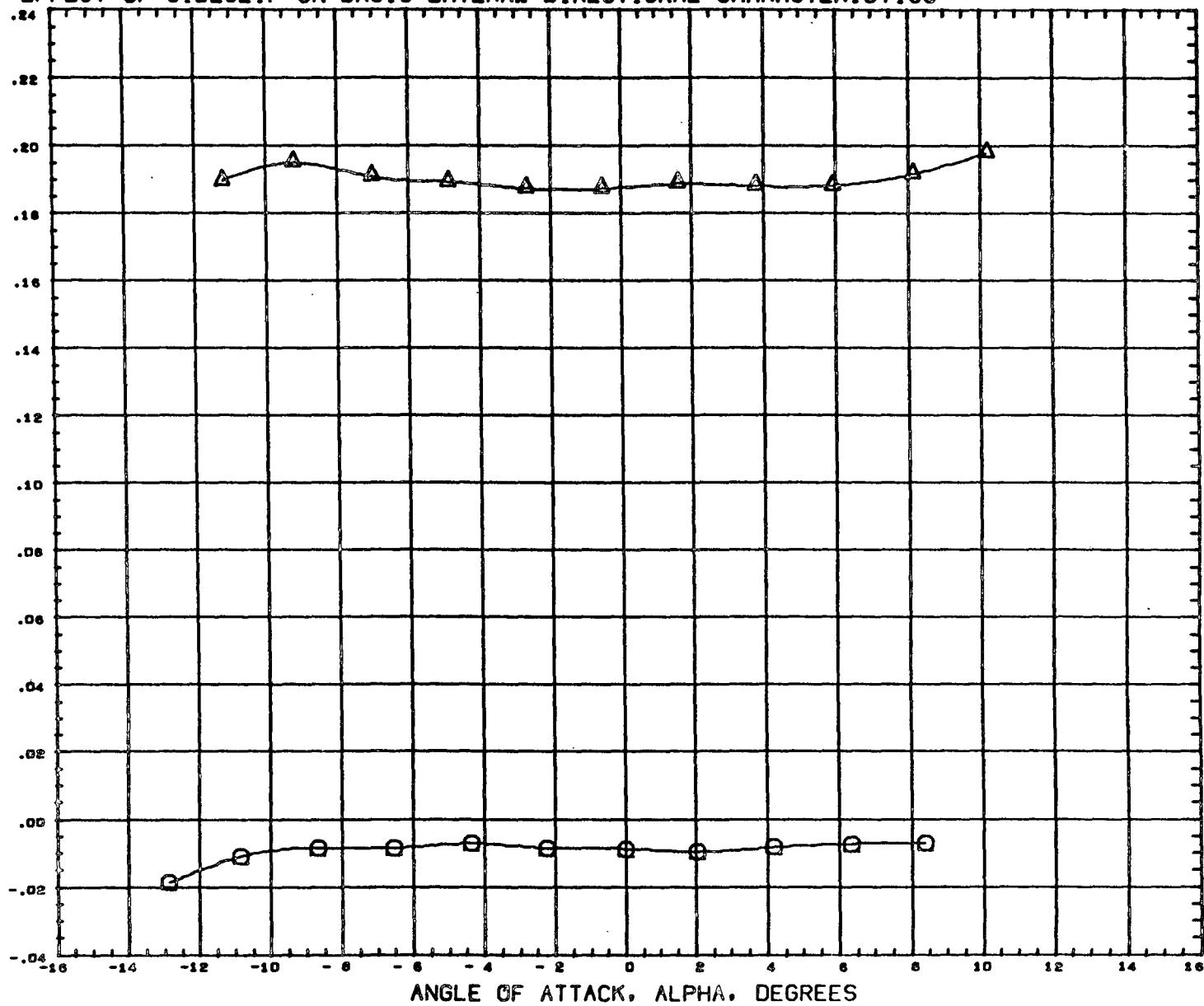
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.602

PAGE 163

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5107A) MSFC509 NR 110C ORBITER + TANK B12W26E16V36  
 (B5106A) MSFC509 NR 110C ORBITER ◊ TANK B12W26Z16V36

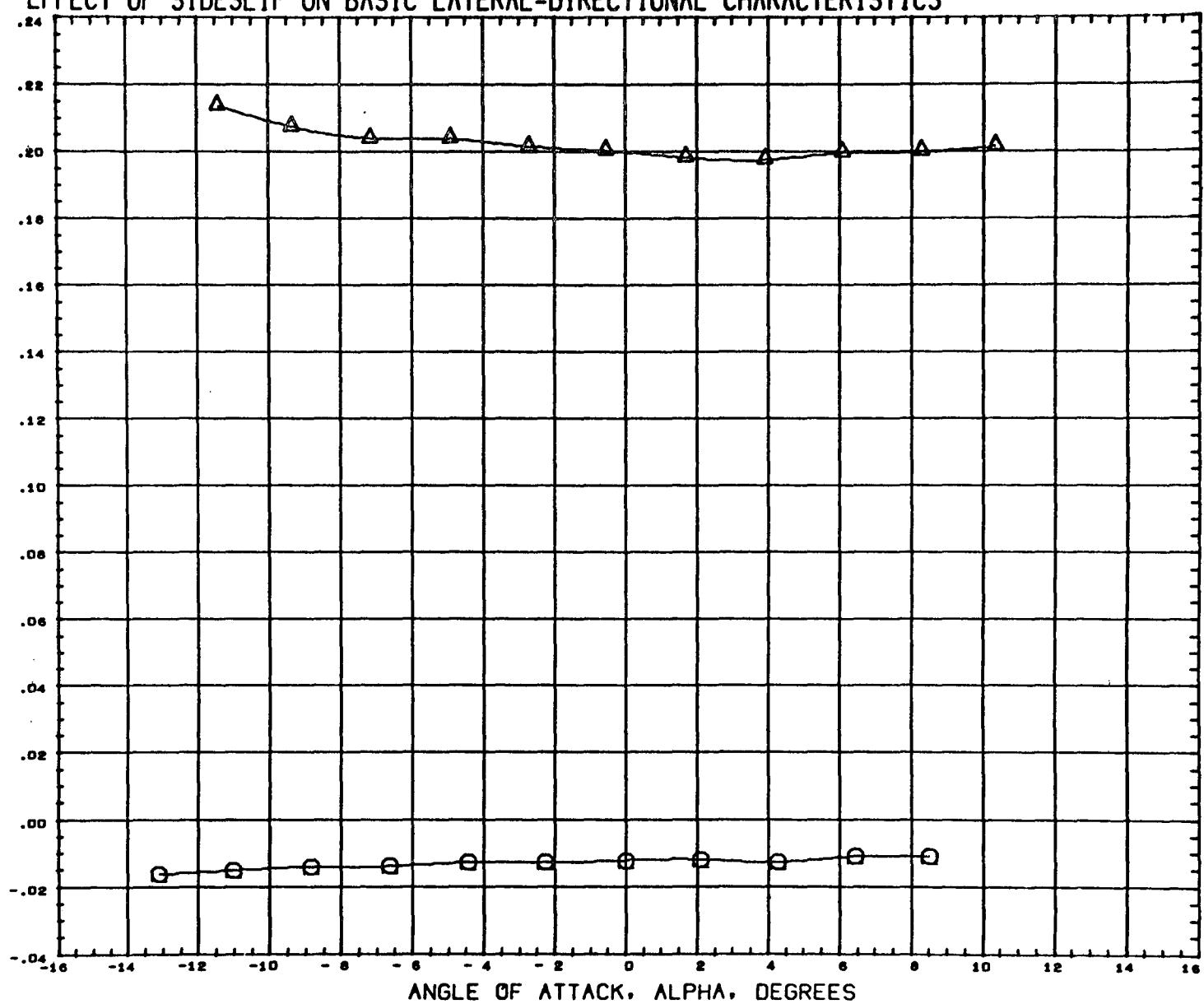
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 SCALE 0.0044 8 SCALE

MACH 0.900

## EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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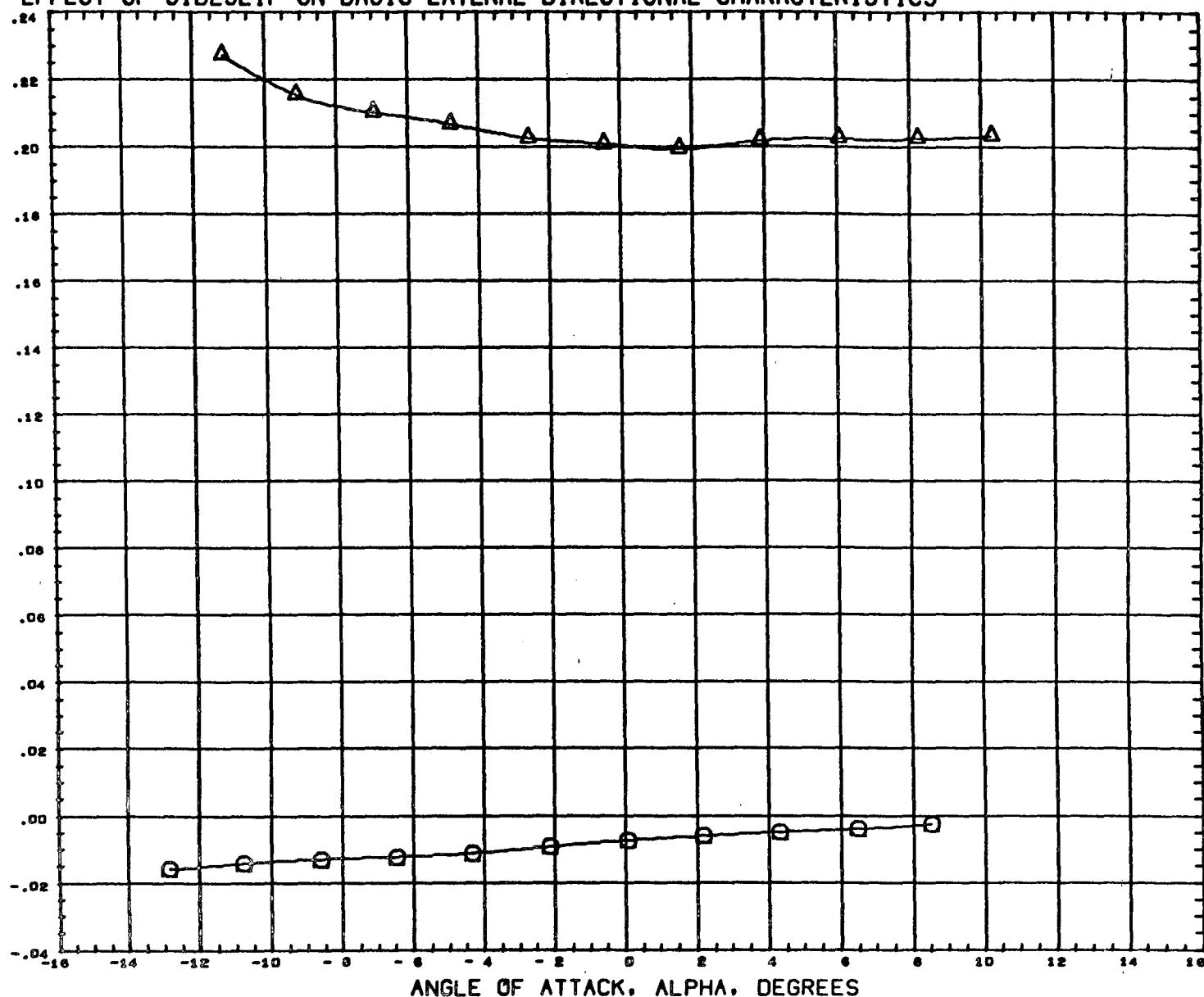
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 XMRP 3.6080 INCHES  
 YMRP 0.0000 INCHES  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.198

PAGE 165

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5107A) MSFC5D9 NR 110C ORBITER + TANK B12W26E16V36  
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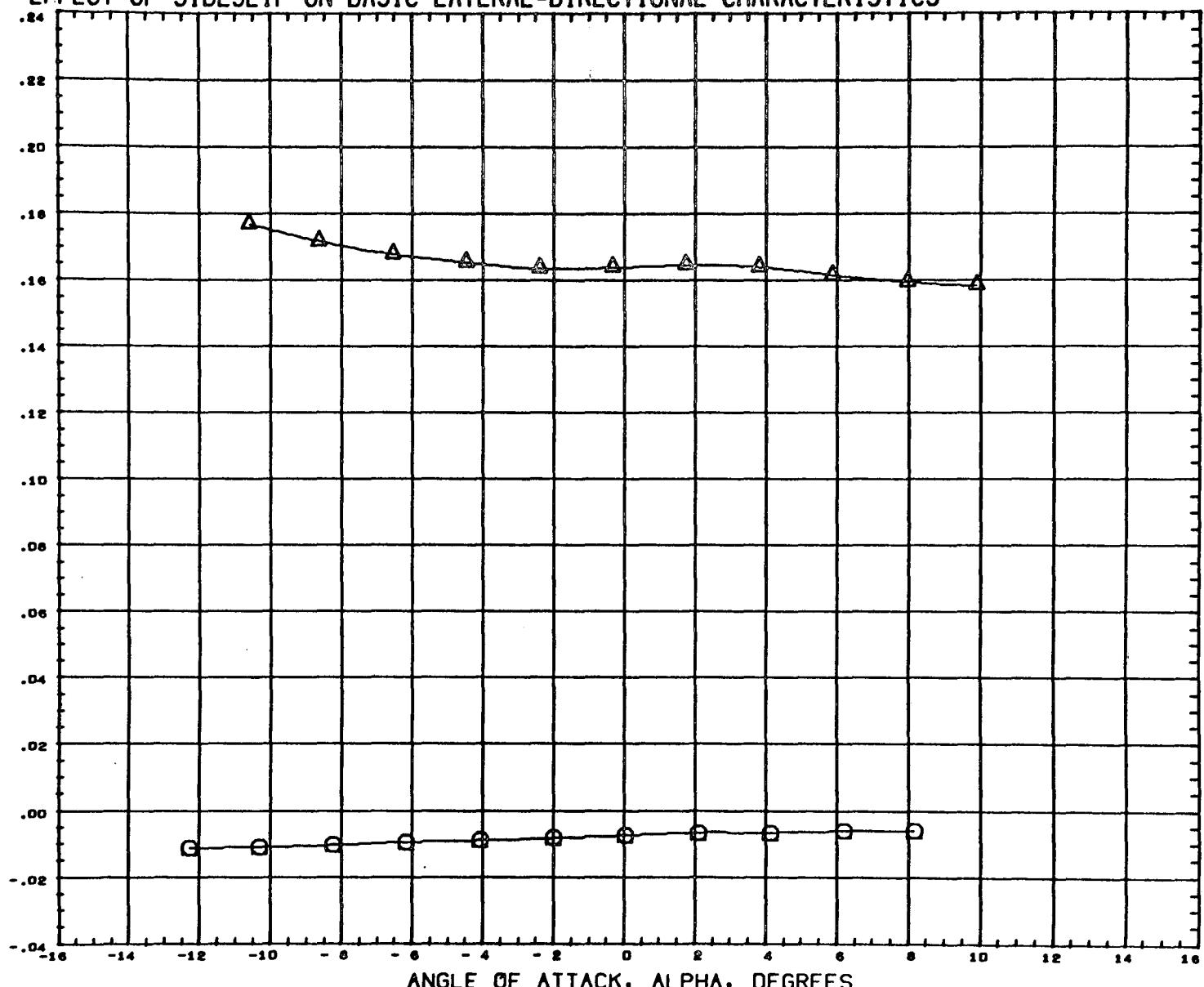
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 SCALE 0.0044 SCALE

MACH 8.965

PAGE 166

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT, CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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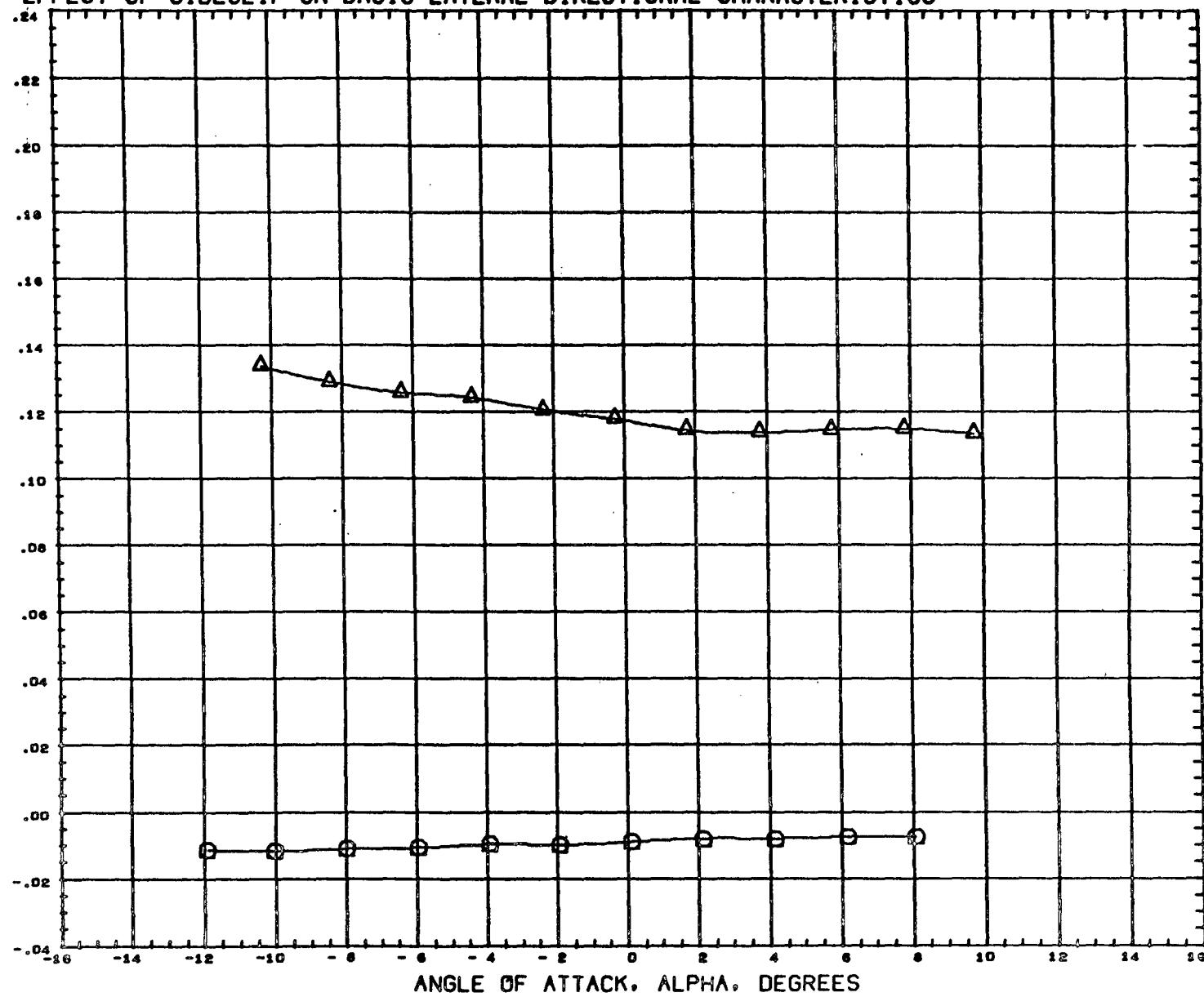
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MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

LATERAL FORCE COEFFICIENT. CY



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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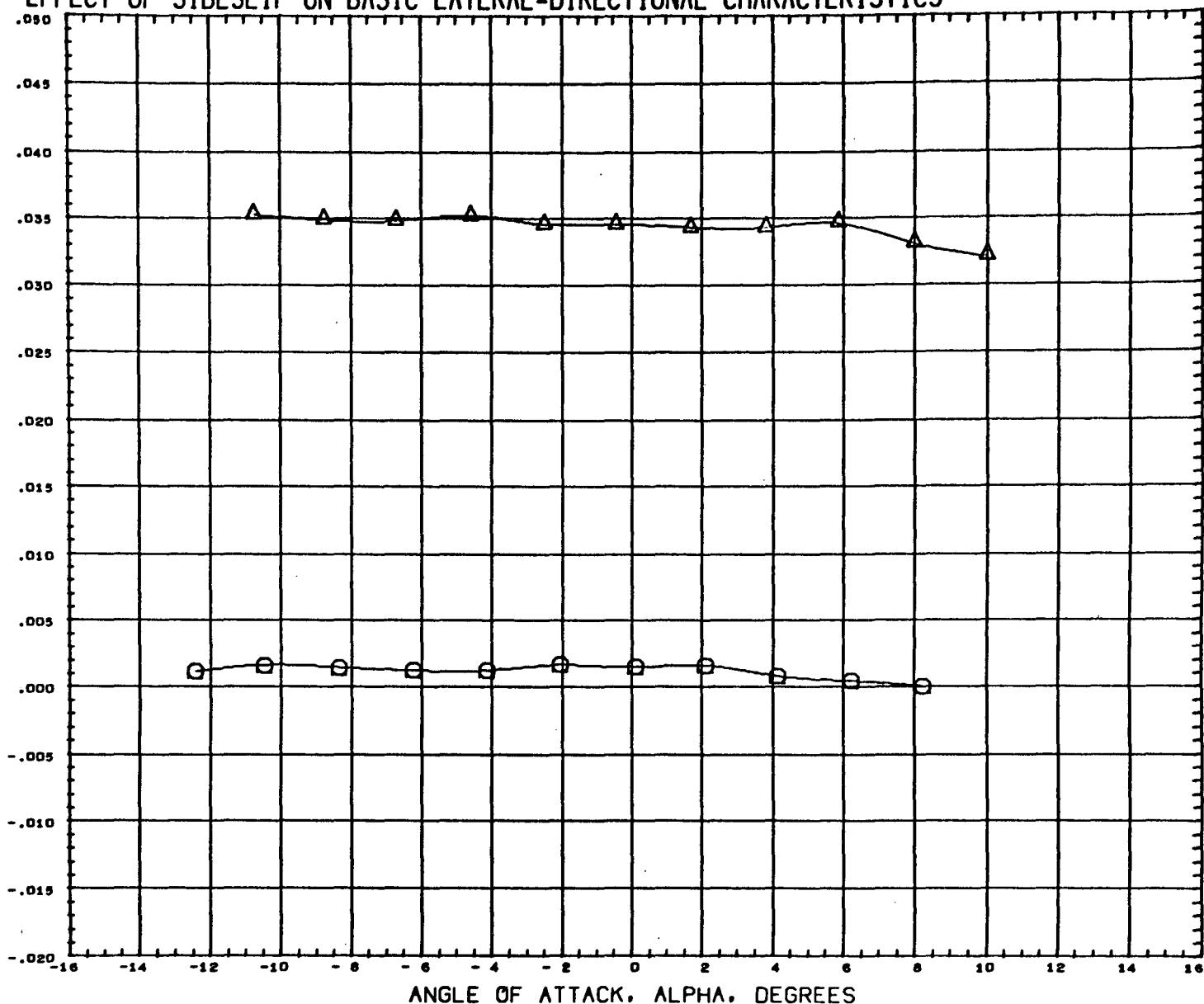
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 SCALE 0.0044 SCALE

MACH 4.059

PAGE 168

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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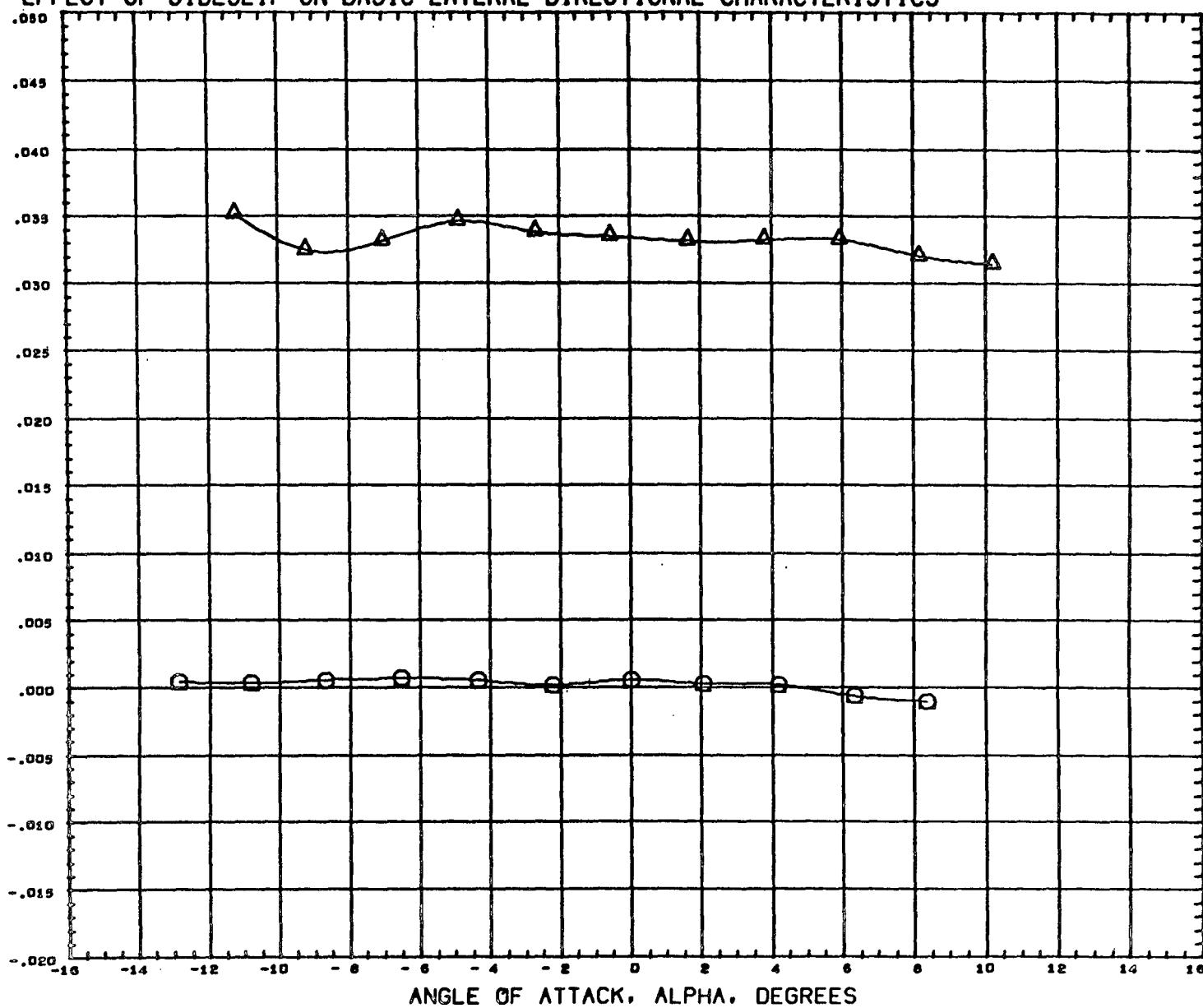
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 SCALE 0.0044 SCALE

MACH 0.602

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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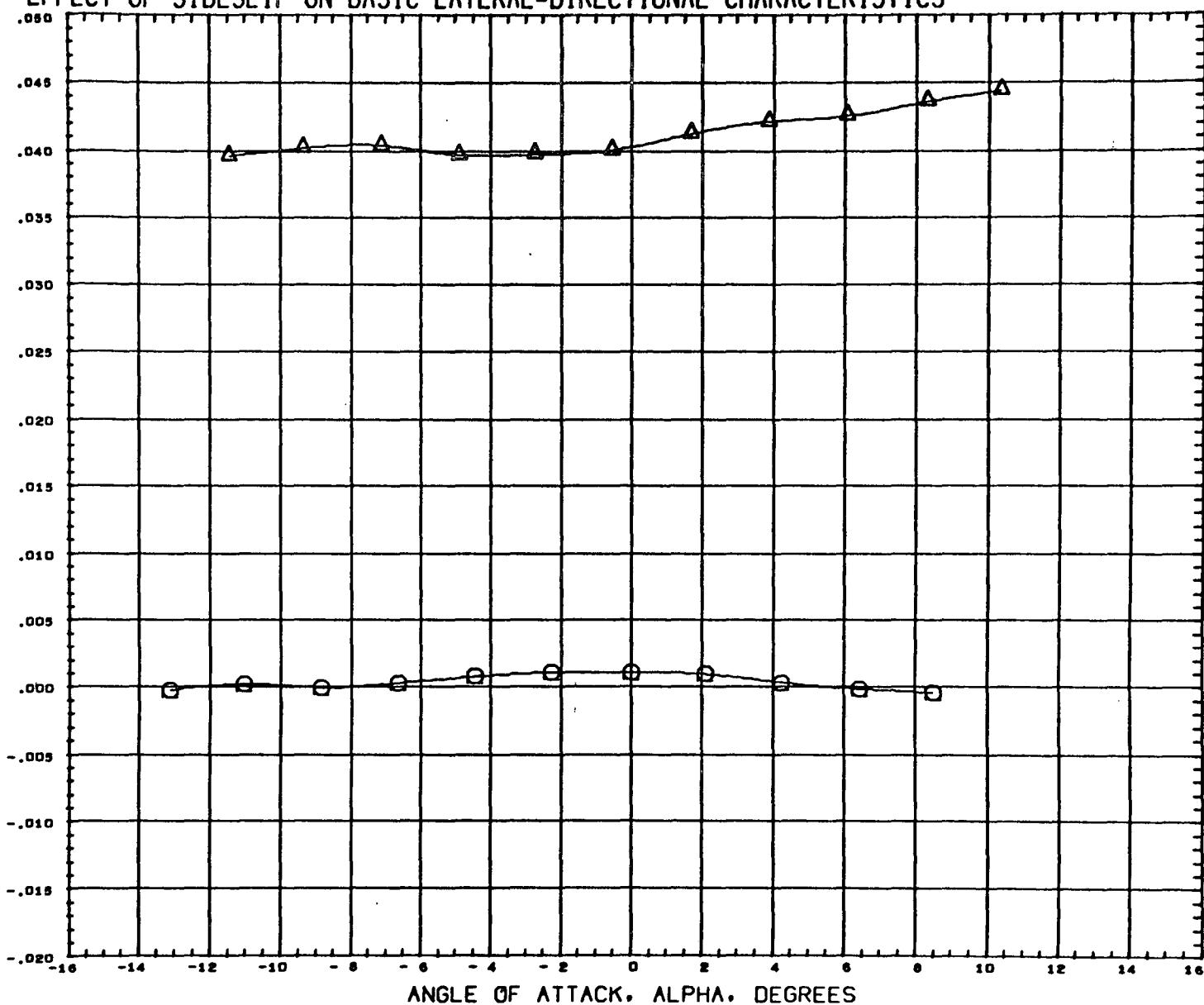
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 SCALE 0.0044 SCALE

MACH 0.900

PAGE 170

## EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5107A) MSFC509 NR 11OC ORBITER + TANK B12W26E16V36  
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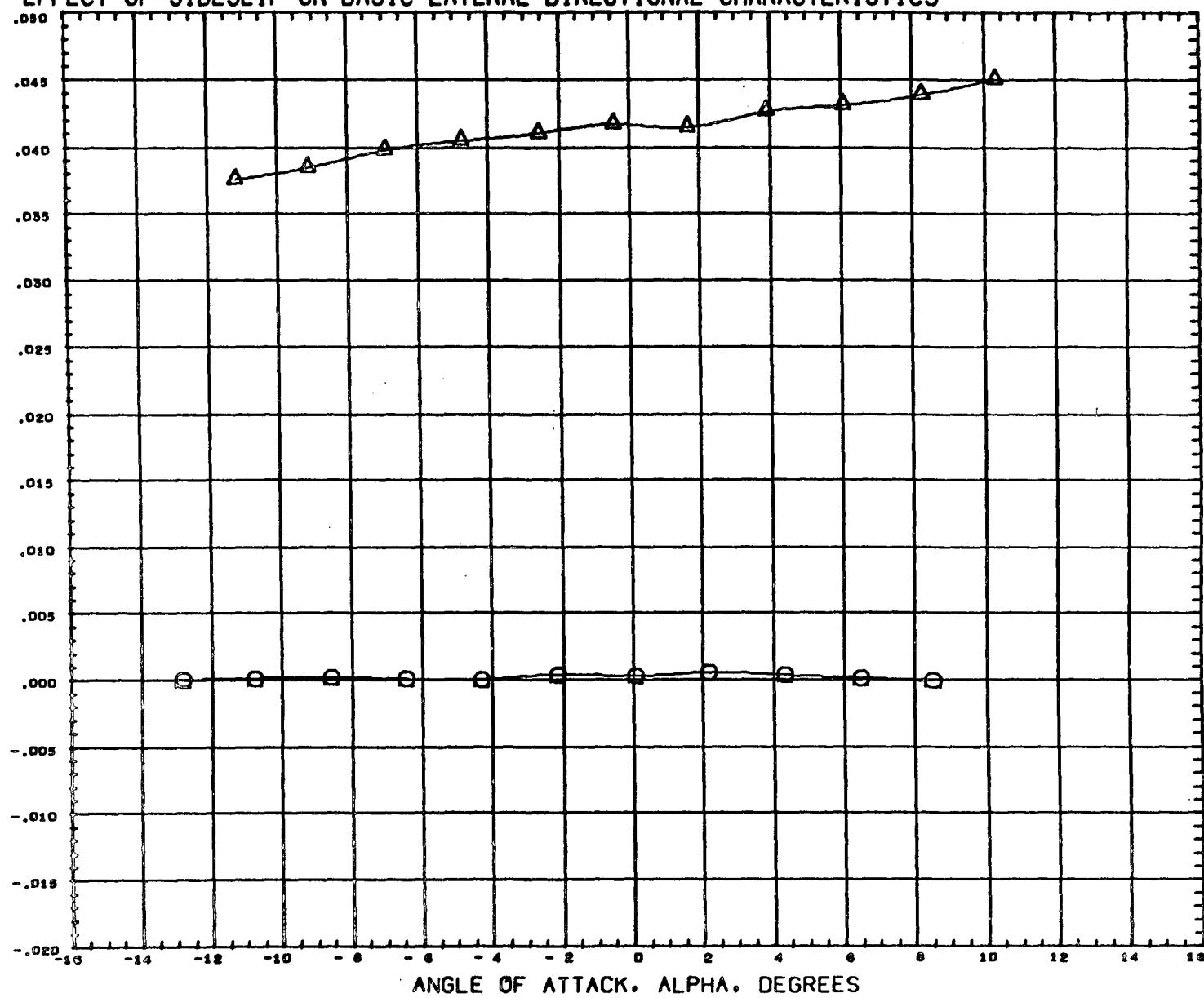
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 SCALE 0.0044 SCALE

MACH 1.198

PAGE 171

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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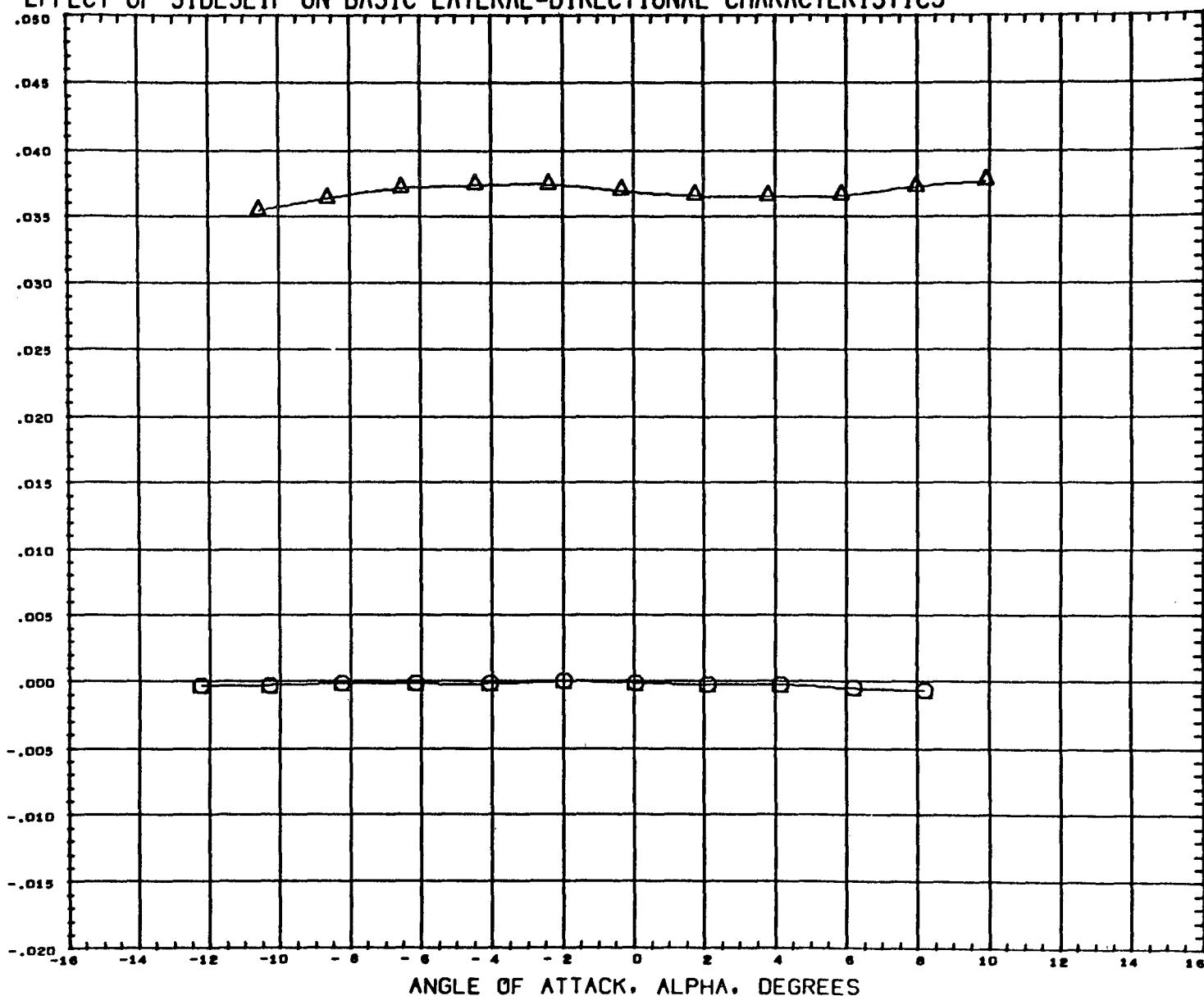
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 8.965

PAGE 172

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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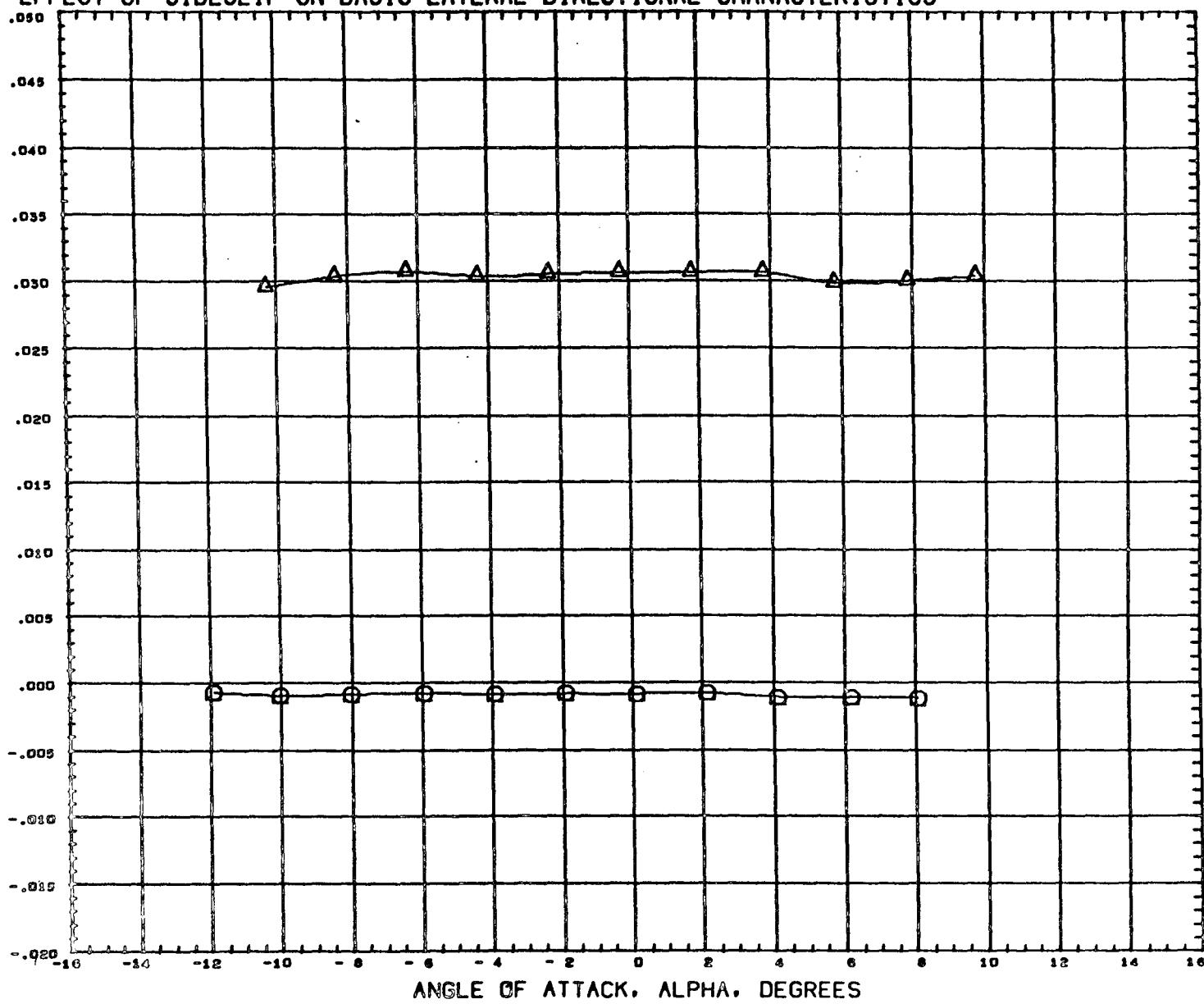
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 SCALE 0.0044 SCALE

MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (B5107A) M9FC5D9 NR 11OC ORBITER + TANK B12W26E16V36  
 (B5106A) M9FC5D9 NR 11OC ORBITER + TANK B12W26E16V36

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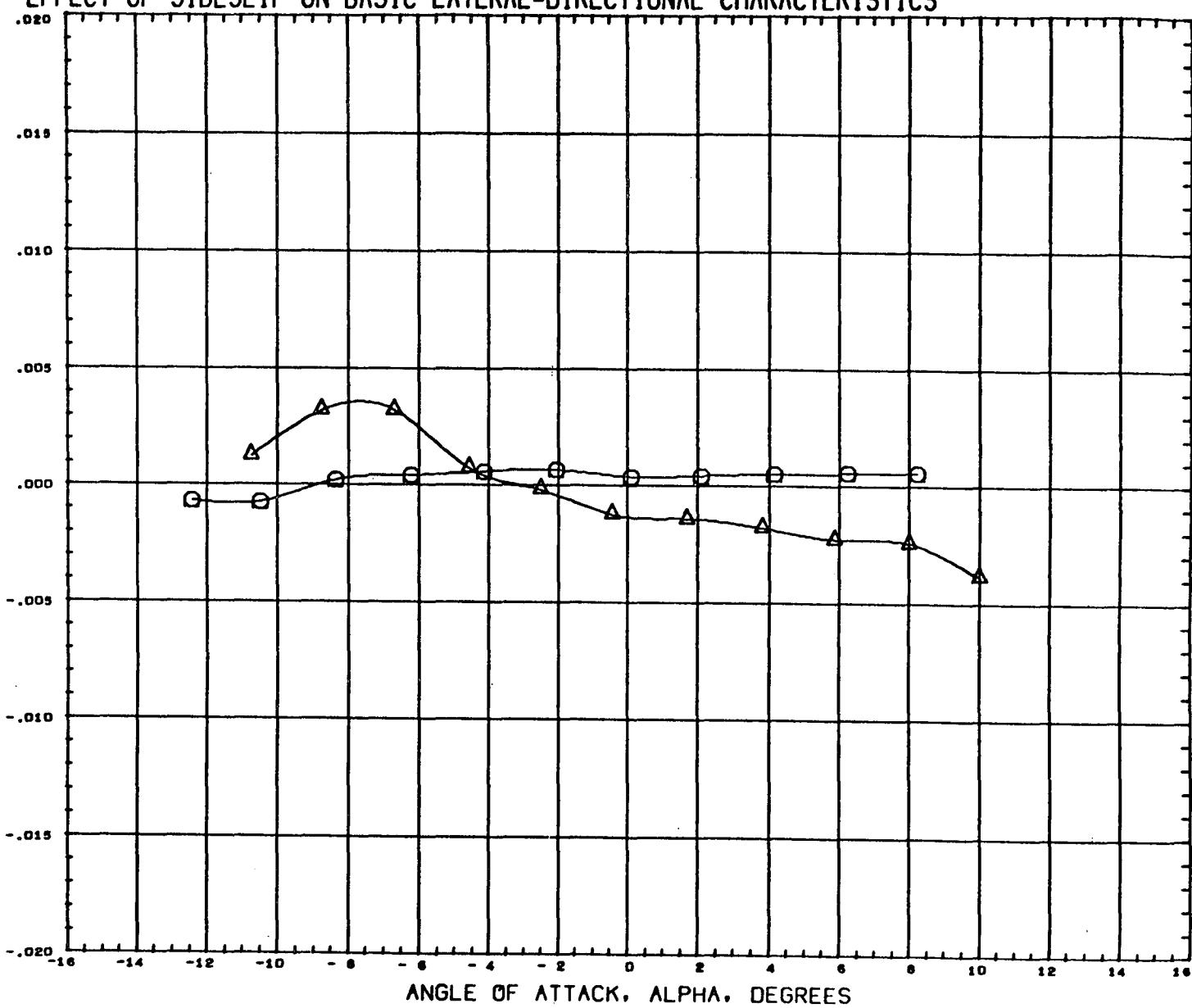
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 SCALE 0.0044 SCALE

MACH 4.099

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# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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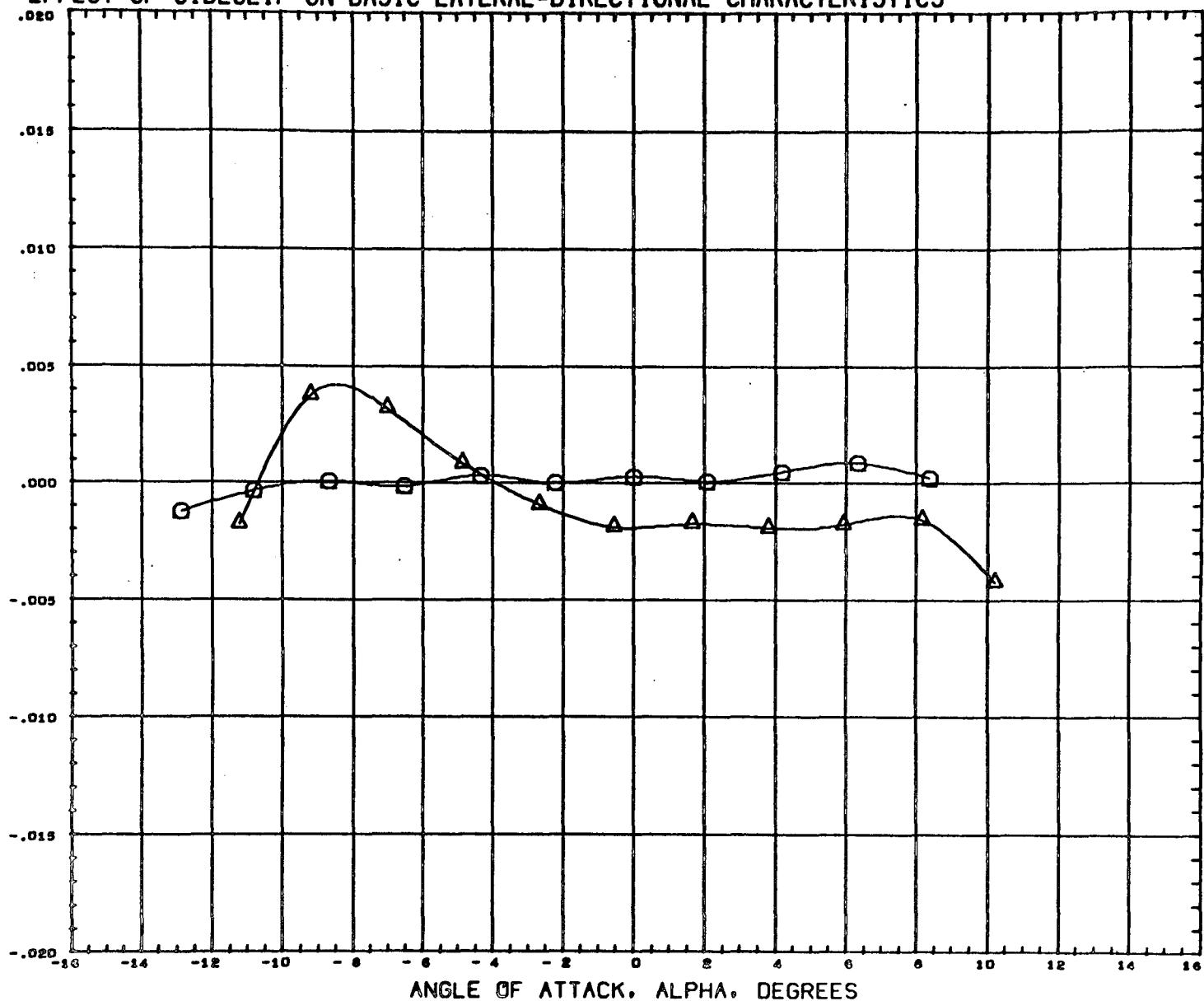
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 ZHRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.602

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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BETA

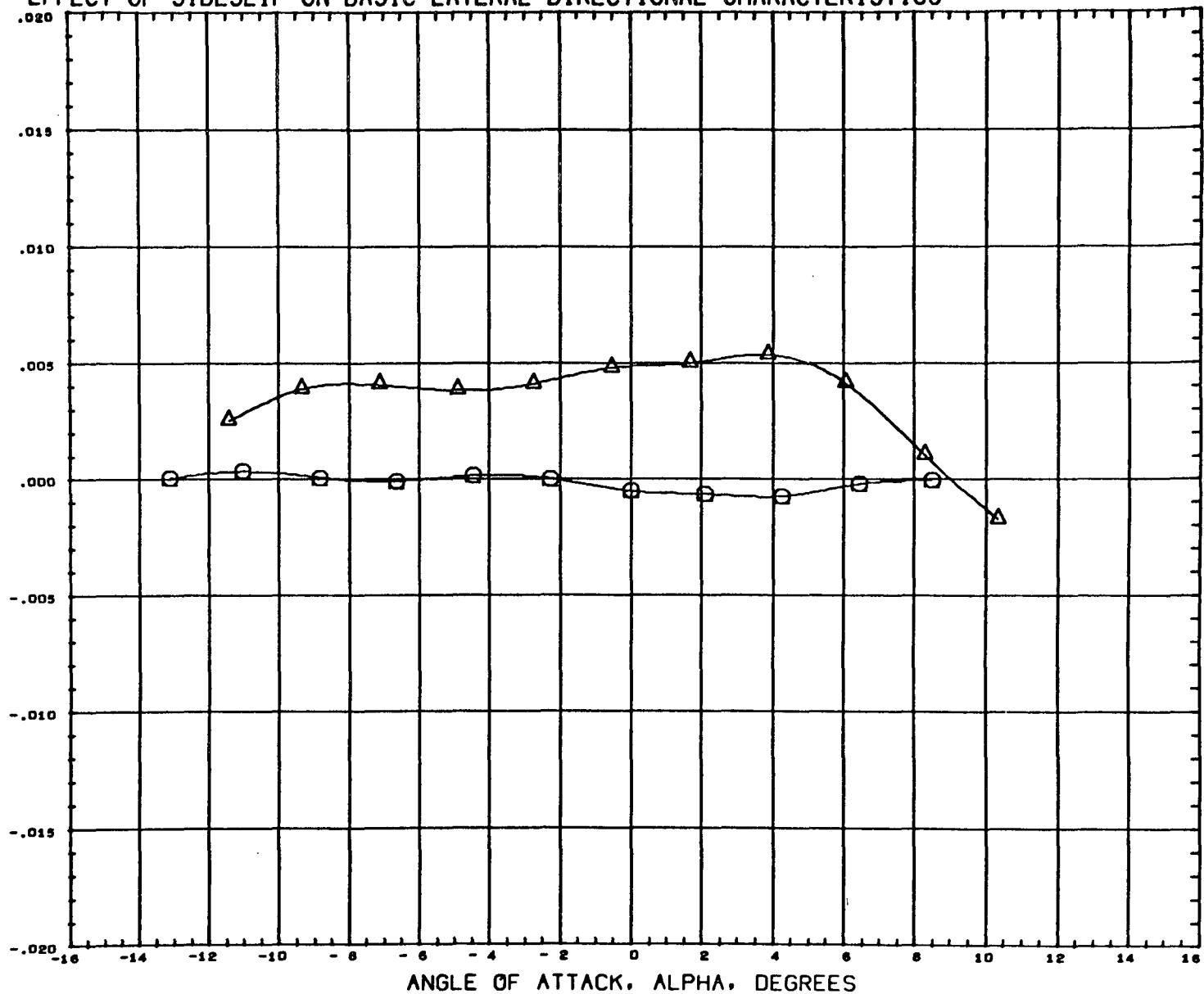
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 ZMRP - 0.0090 INCHES  
 SCALE 0.0044 SCALE

MACH 0.000

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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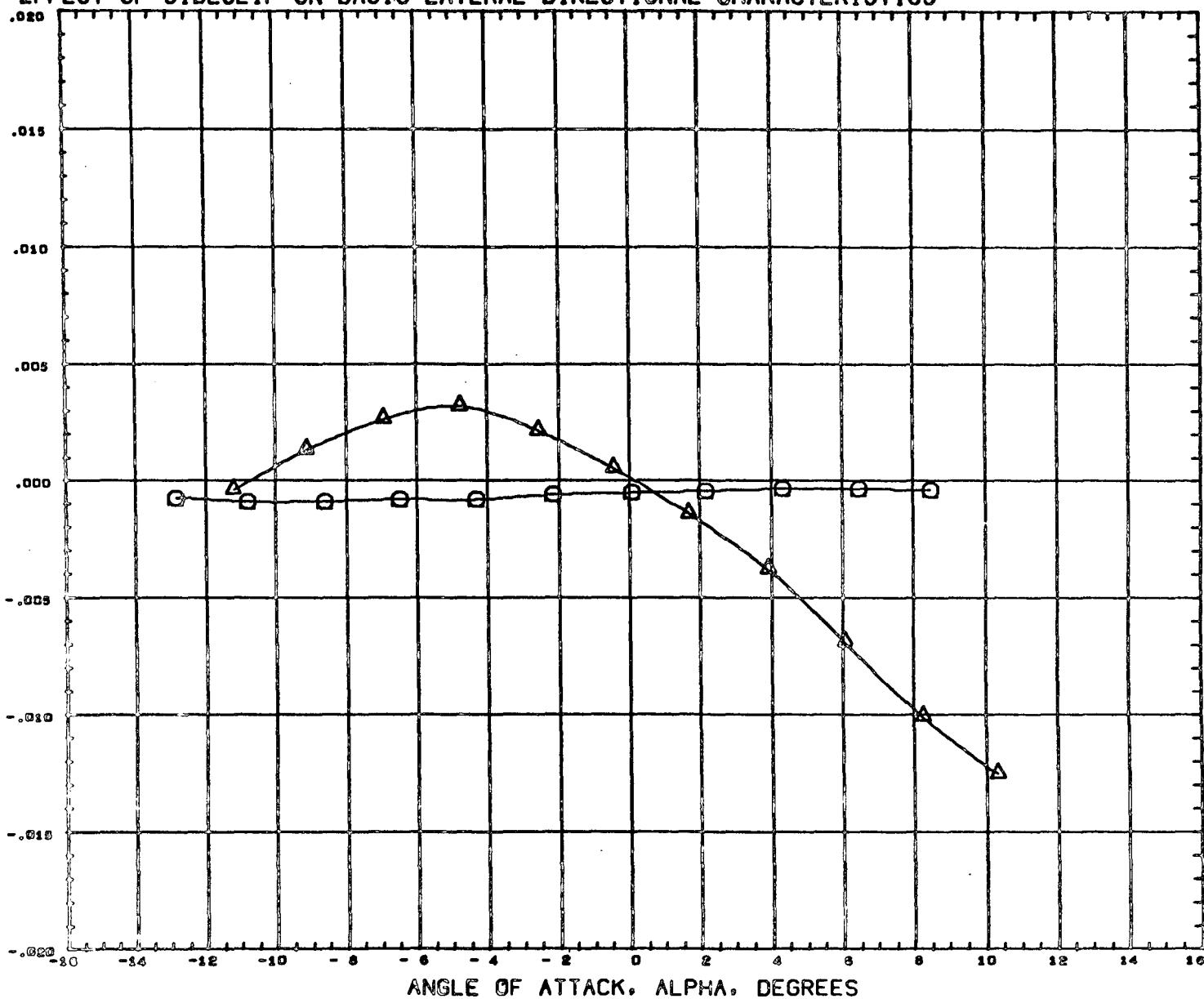
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ZMRP - 0.0990 INCHES
SCALE 0.0044 SCALE

MACH 1.196

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(85107A) M8FC509 NR 11OC ORBITER + TANK B12W26E16V36  
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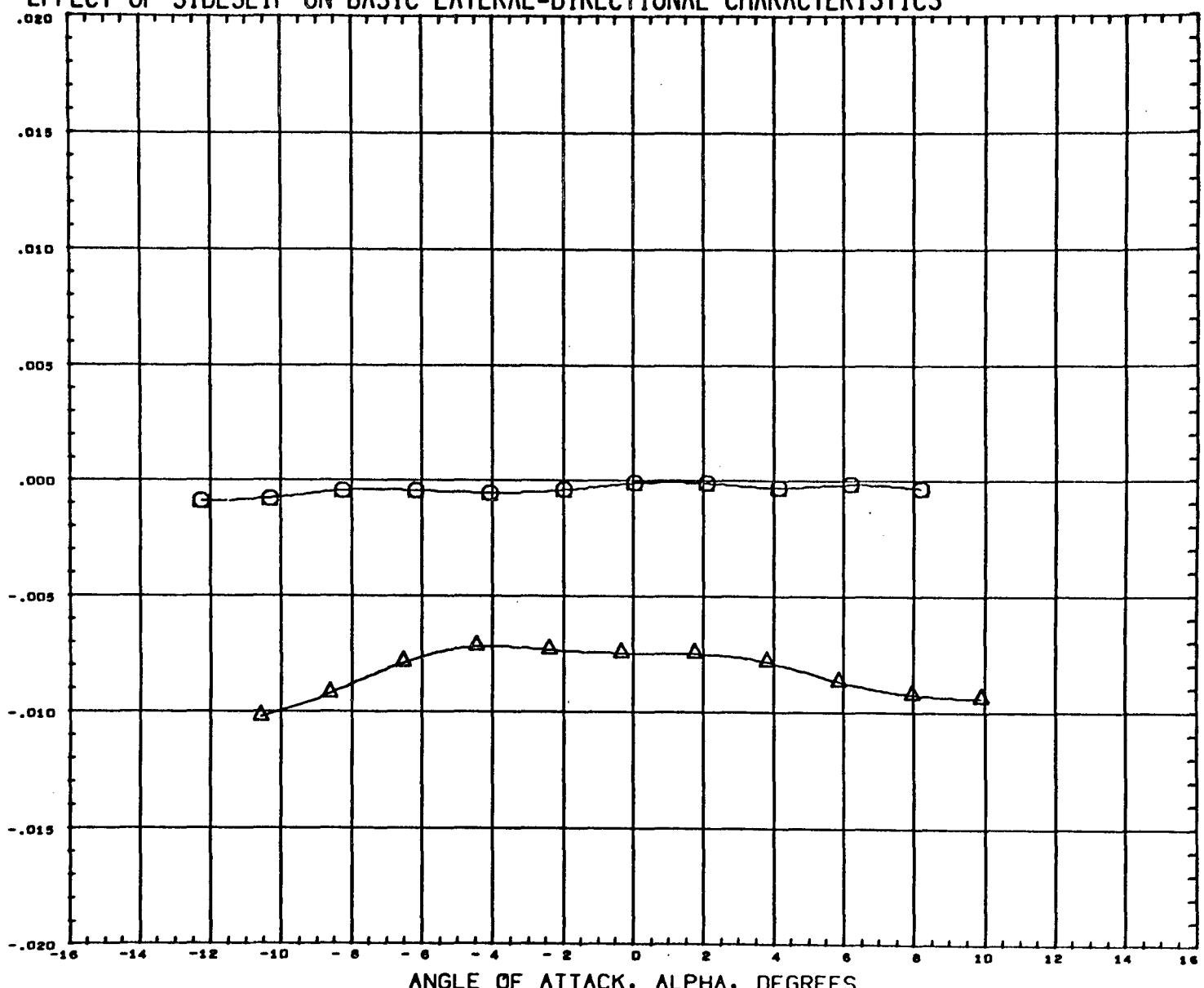
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SCALE	0.0044	SCALE

MACH 8.009

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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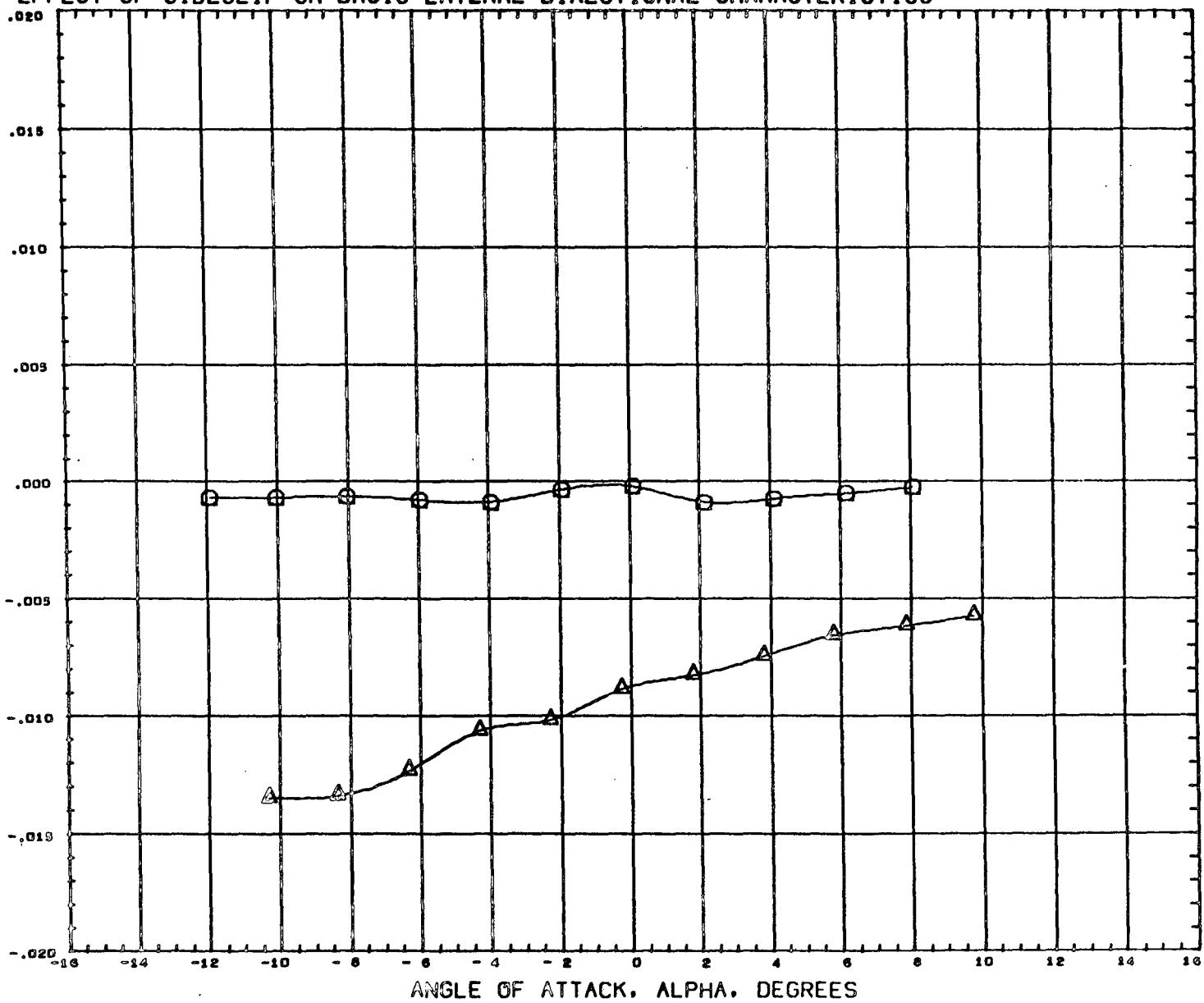
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MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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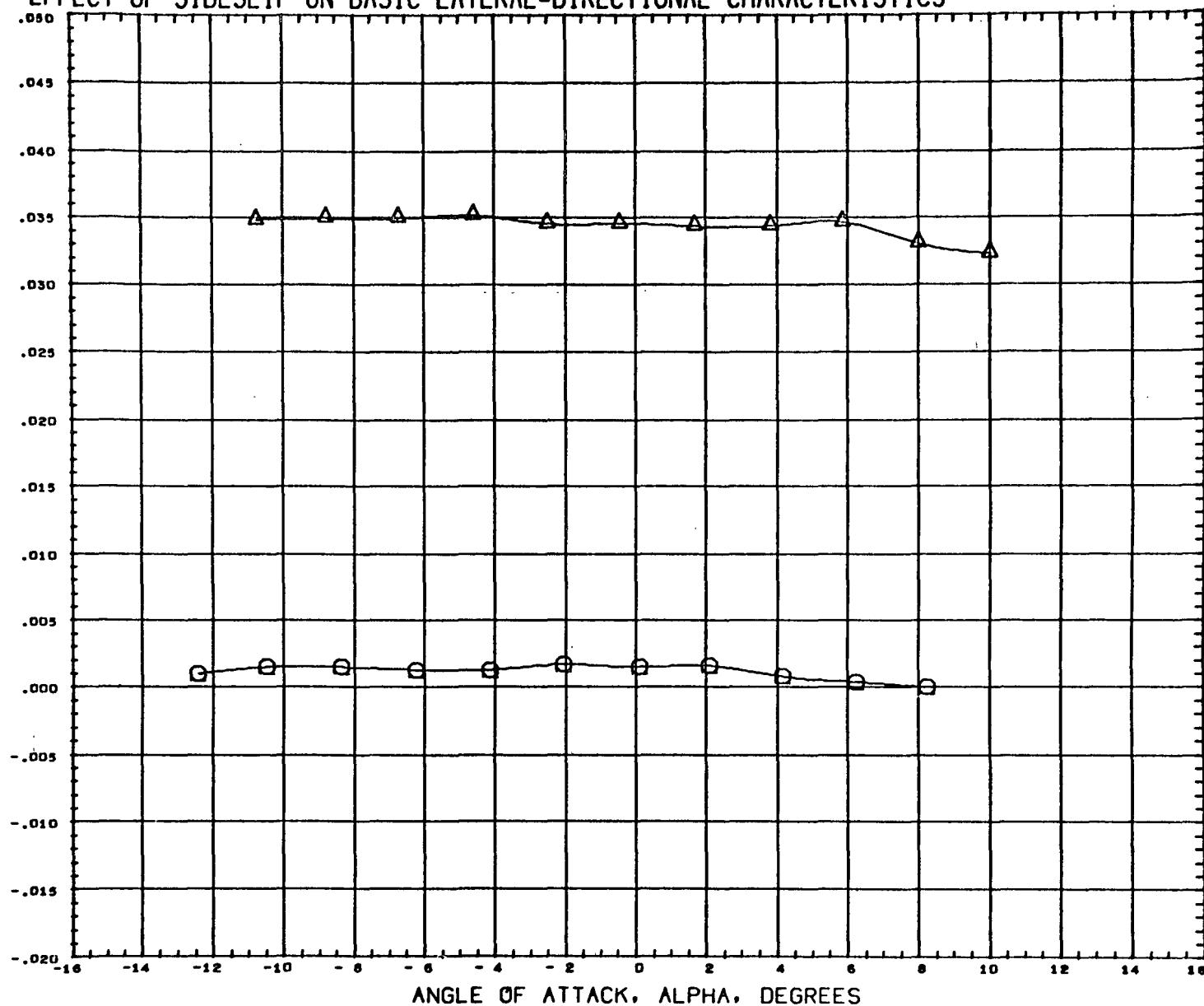
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 4.950

PAGE 180

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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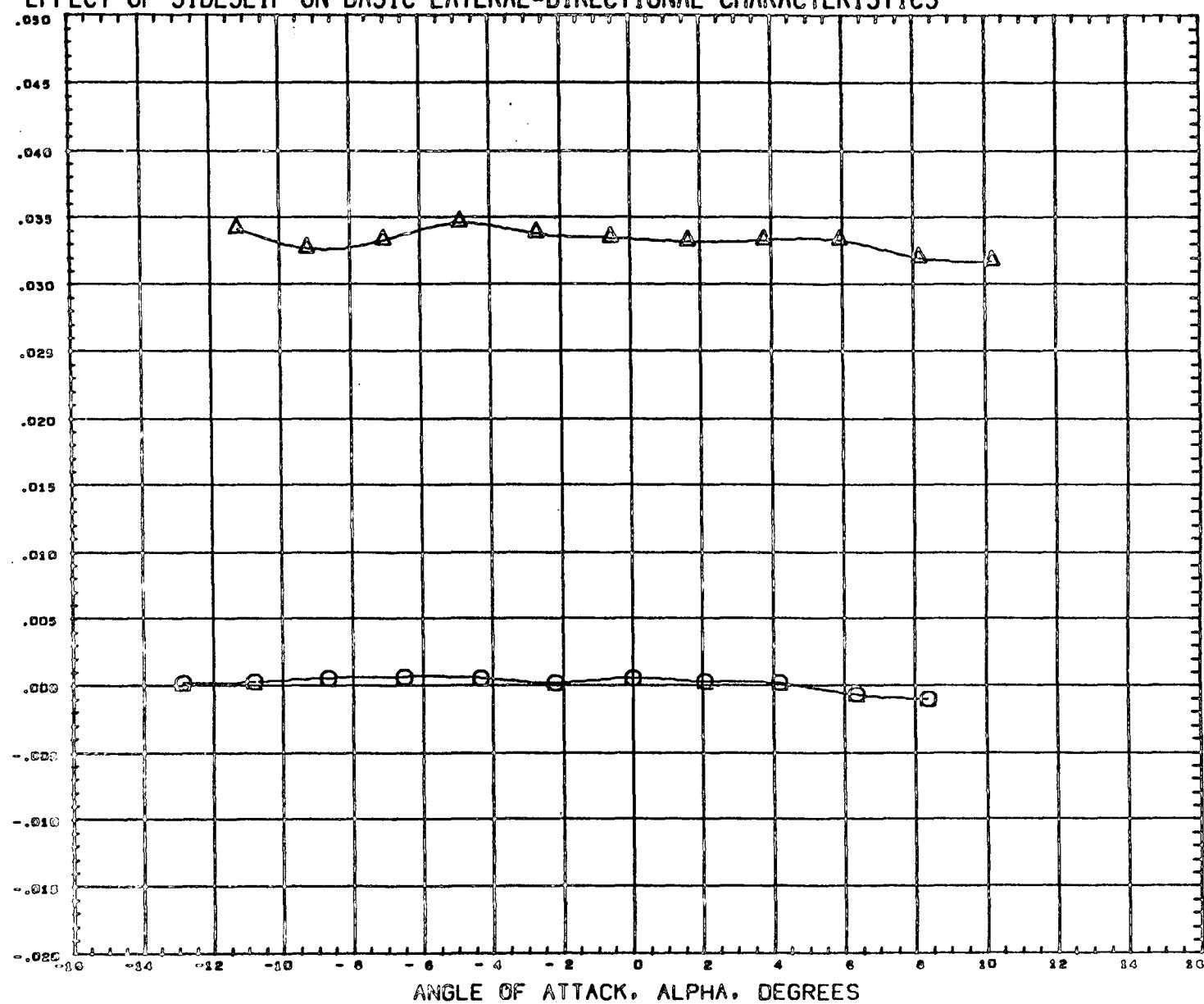
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 SCALE 0.0044 SCALE

MACH 0.602

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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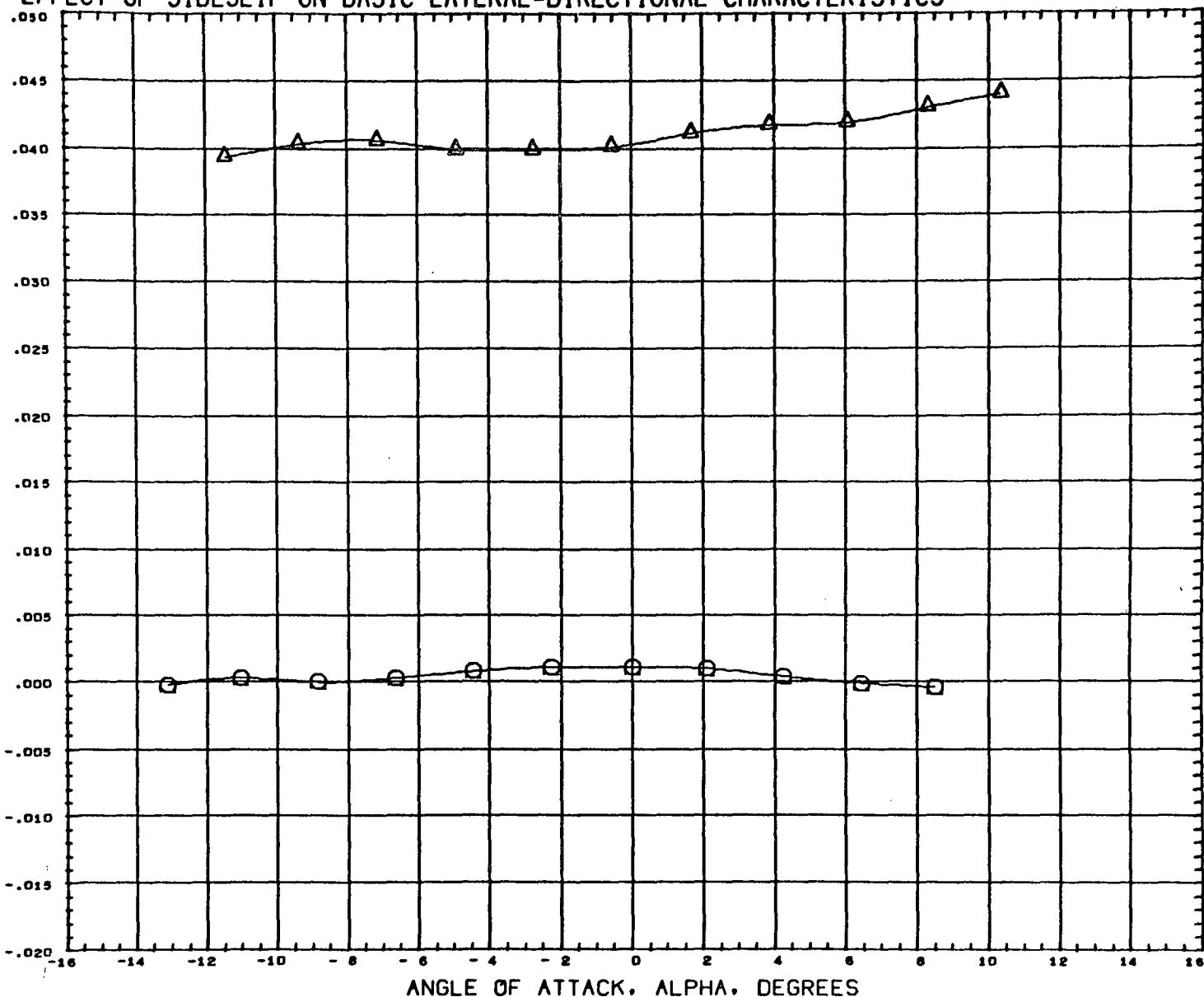
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 0.000

## EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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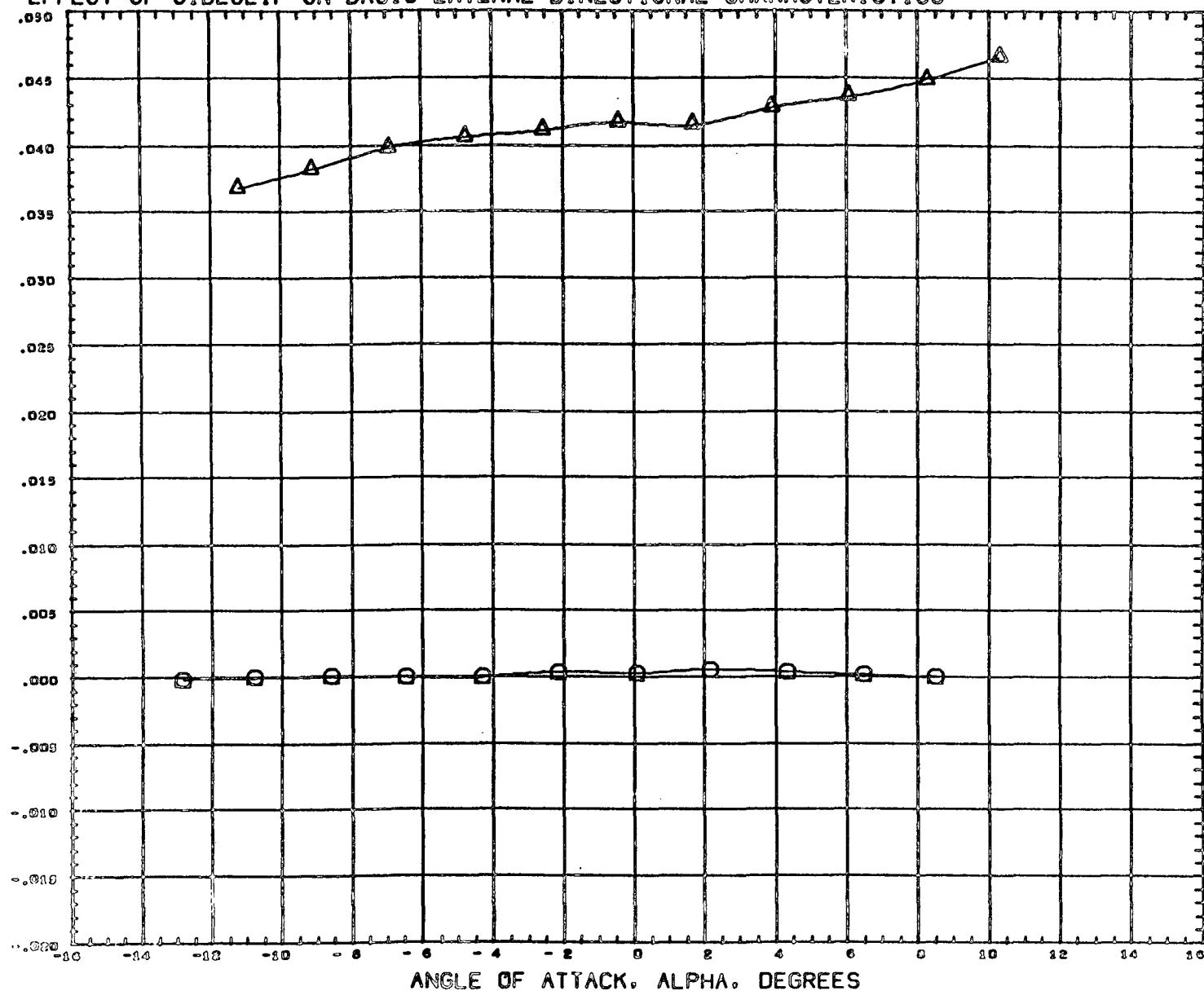
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 1.198

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(A9107A) MOTCS00 NR 110C ORBITER + TANK B12W26E16V96

BETA

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(A9106A) MOTCS00 NR 110C ORBITER + TANK B12W26E16V96

-6.000

REFERENCE INFORMATION

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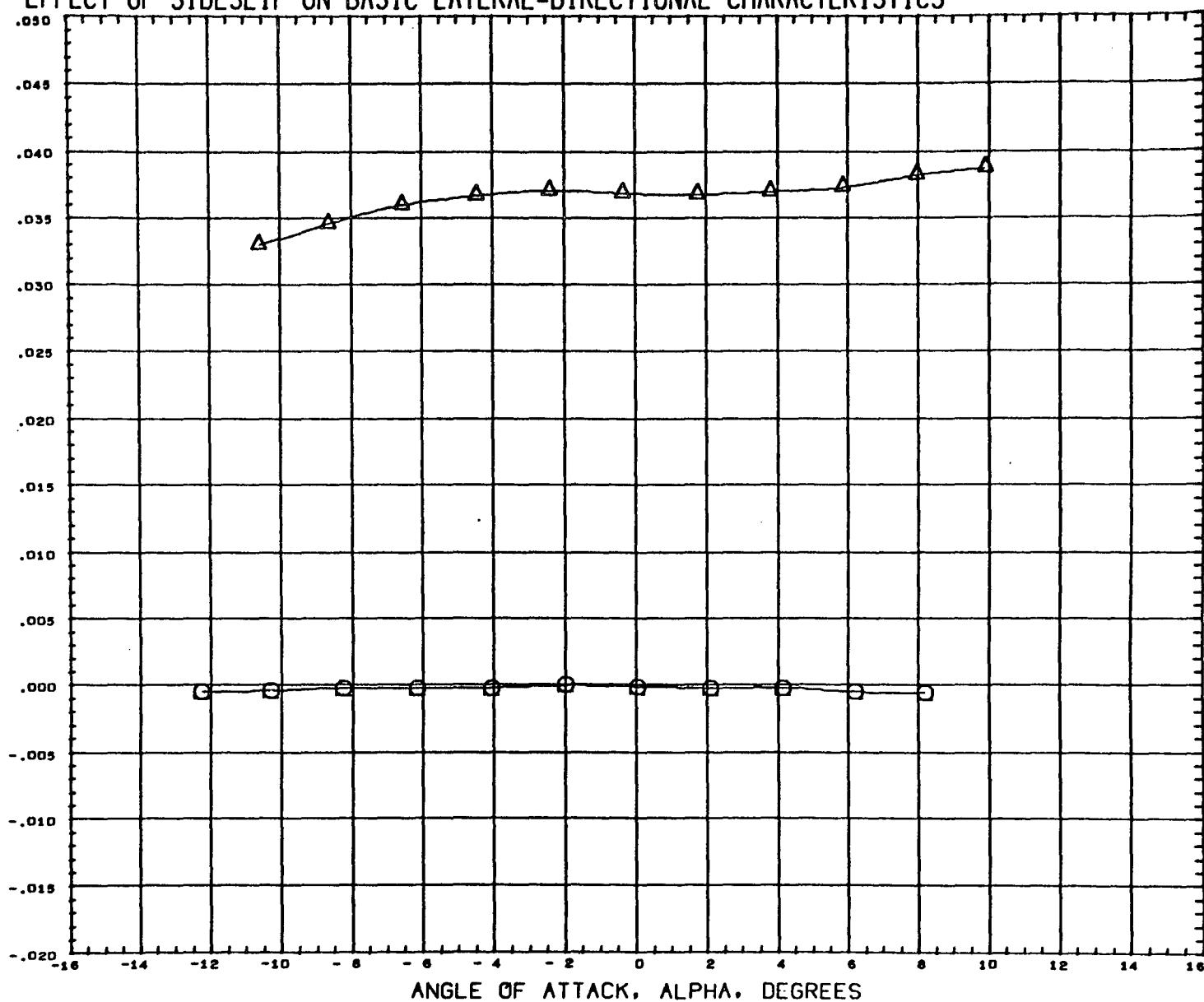
MACH

1.000

PAGE 184

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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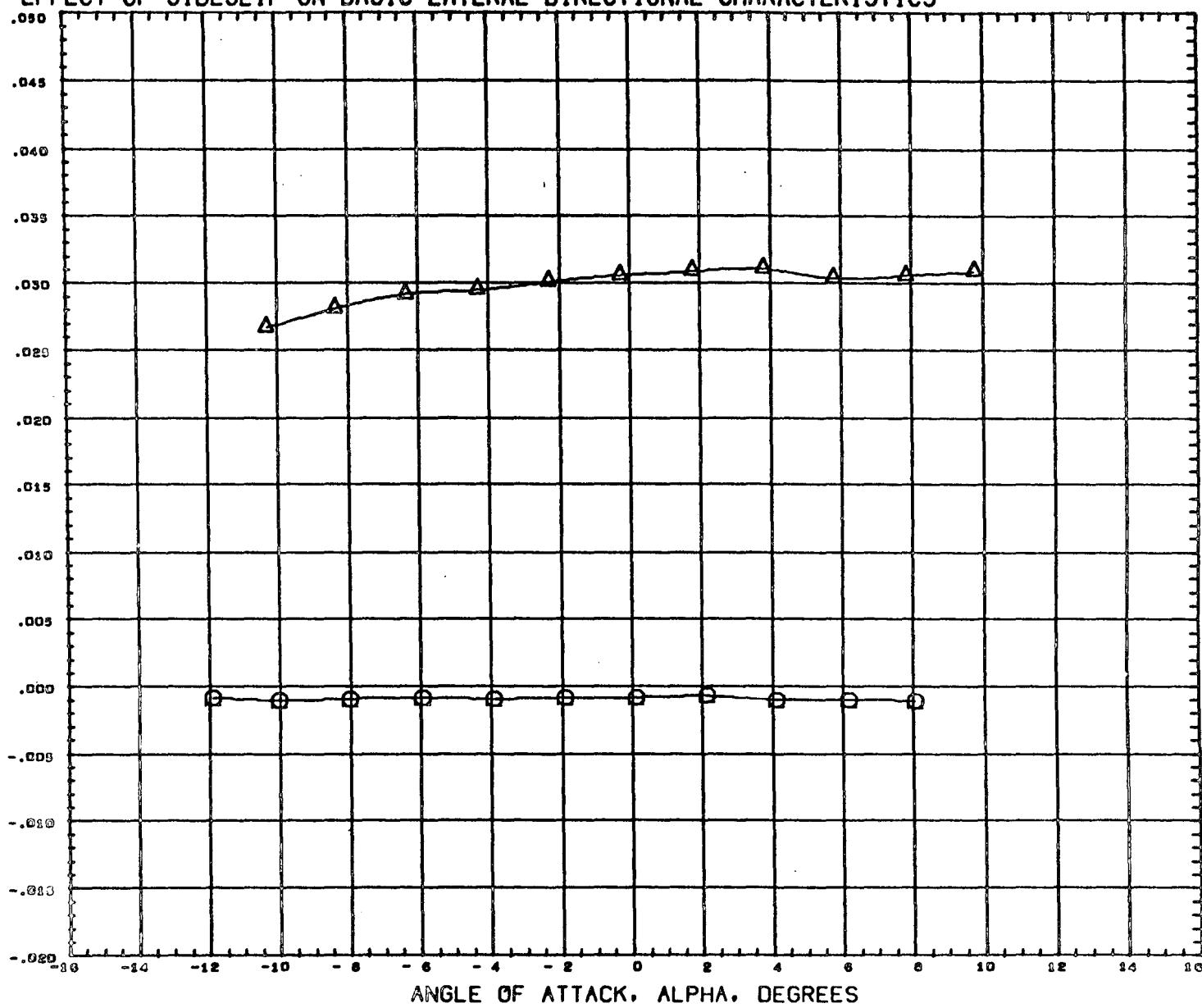
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 2.990

PAGE 185

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

YAWING MOMENT COEFFICIENT, CLN (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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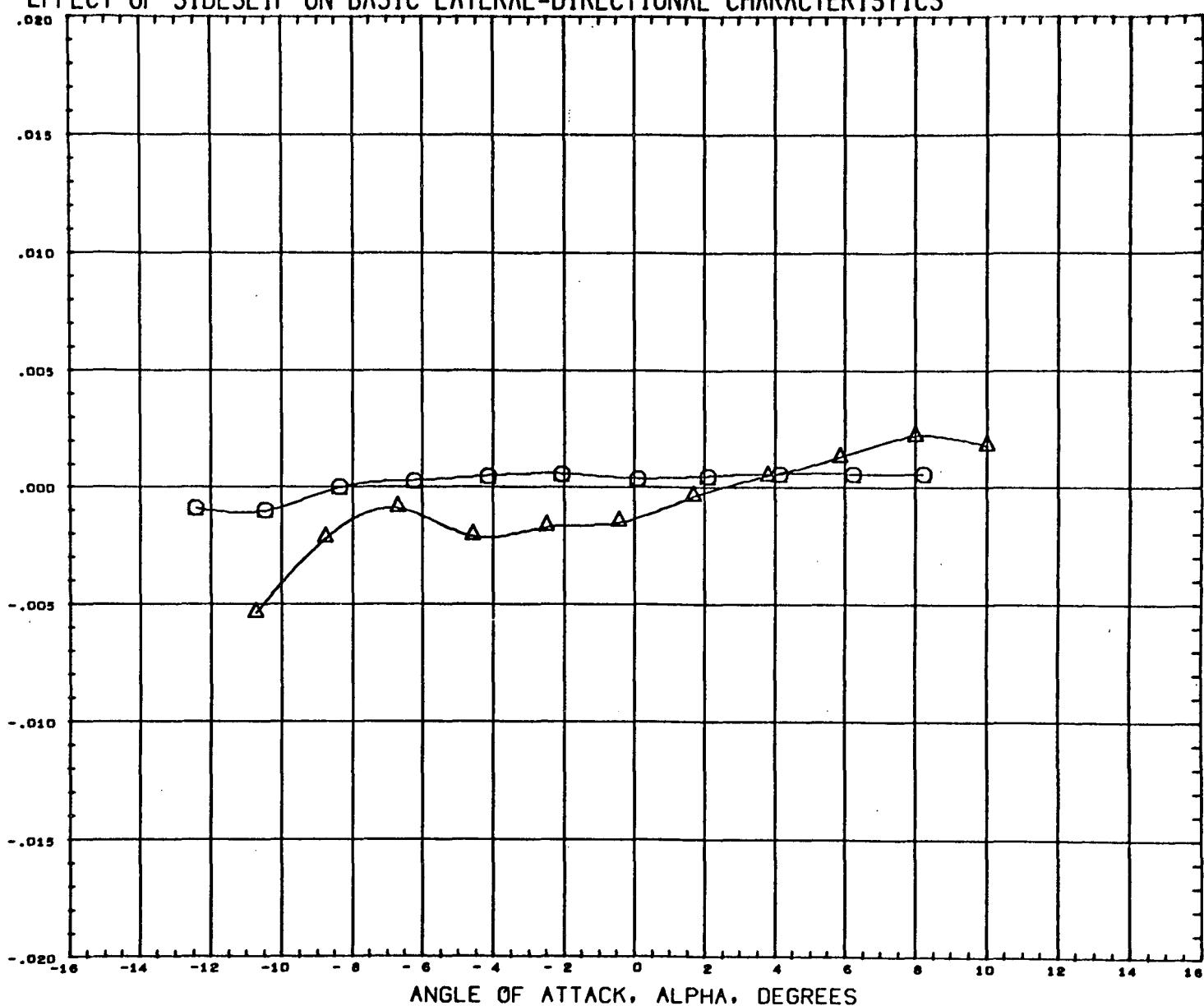
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 4.999

PAGE 186

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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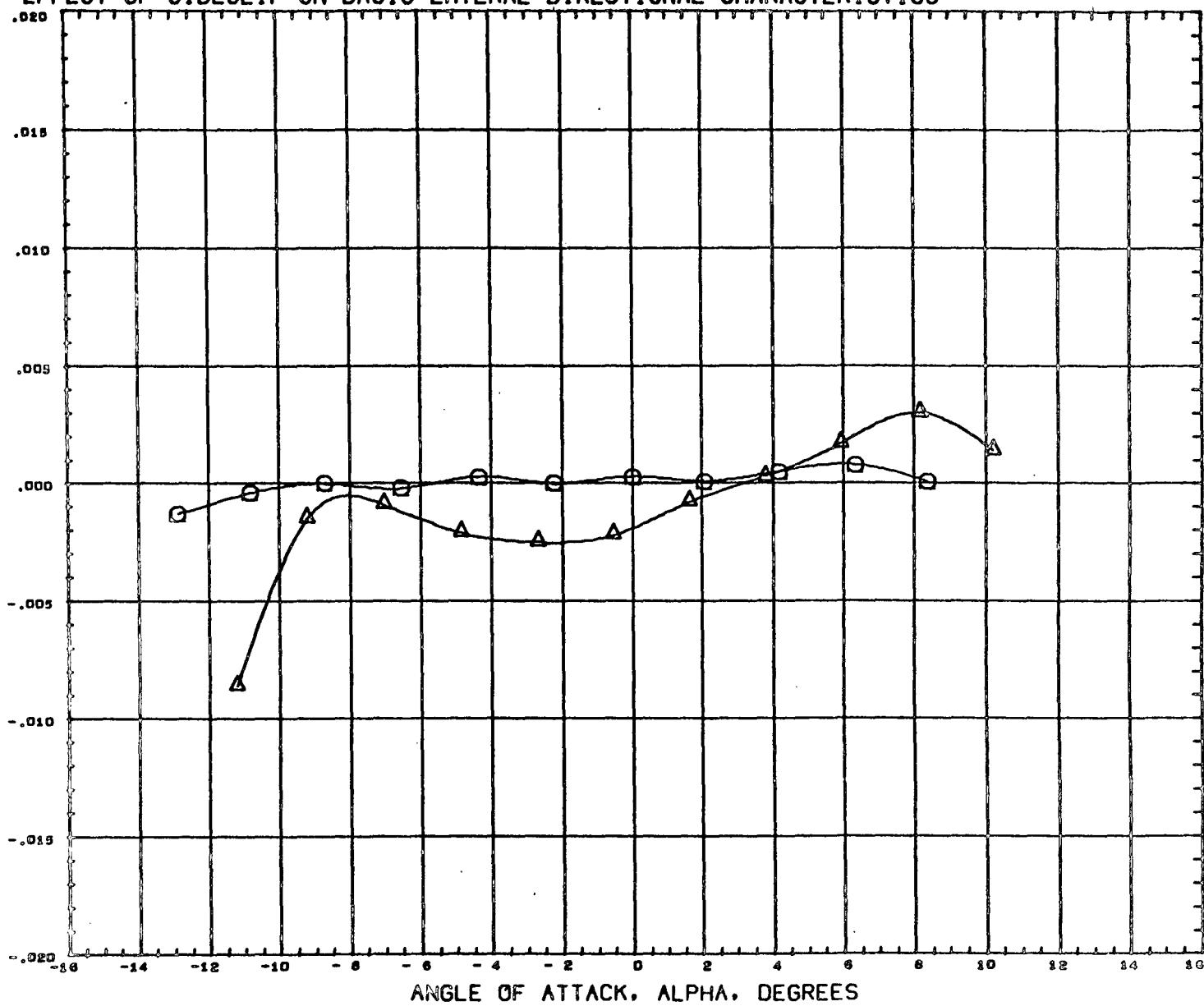
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 SCALE 0.0044 SCALE

MACH 0.602

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
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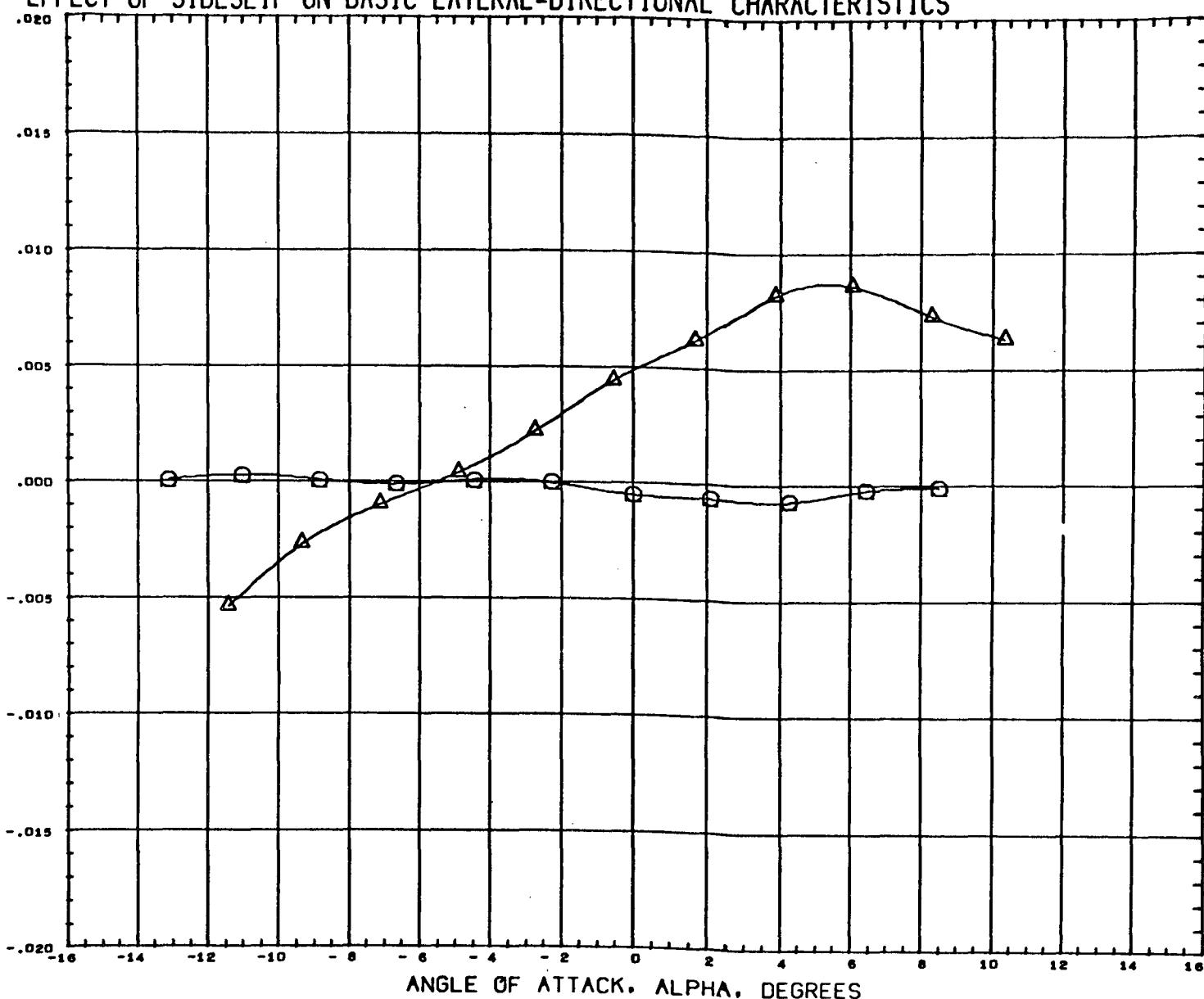
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 YMRP 0.0000 INCHES  
 ZMRP - 0.0990 INCHES  
 SCALE 0.0004 SCALE

MACH 0.000

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(A5107A) MSFC509 NR 110C ORBITER + TANK B12W26E16V36  
 (A5106A) MSFC509 NR 110C ORBITER + TANK B12W26E16V36

BETA

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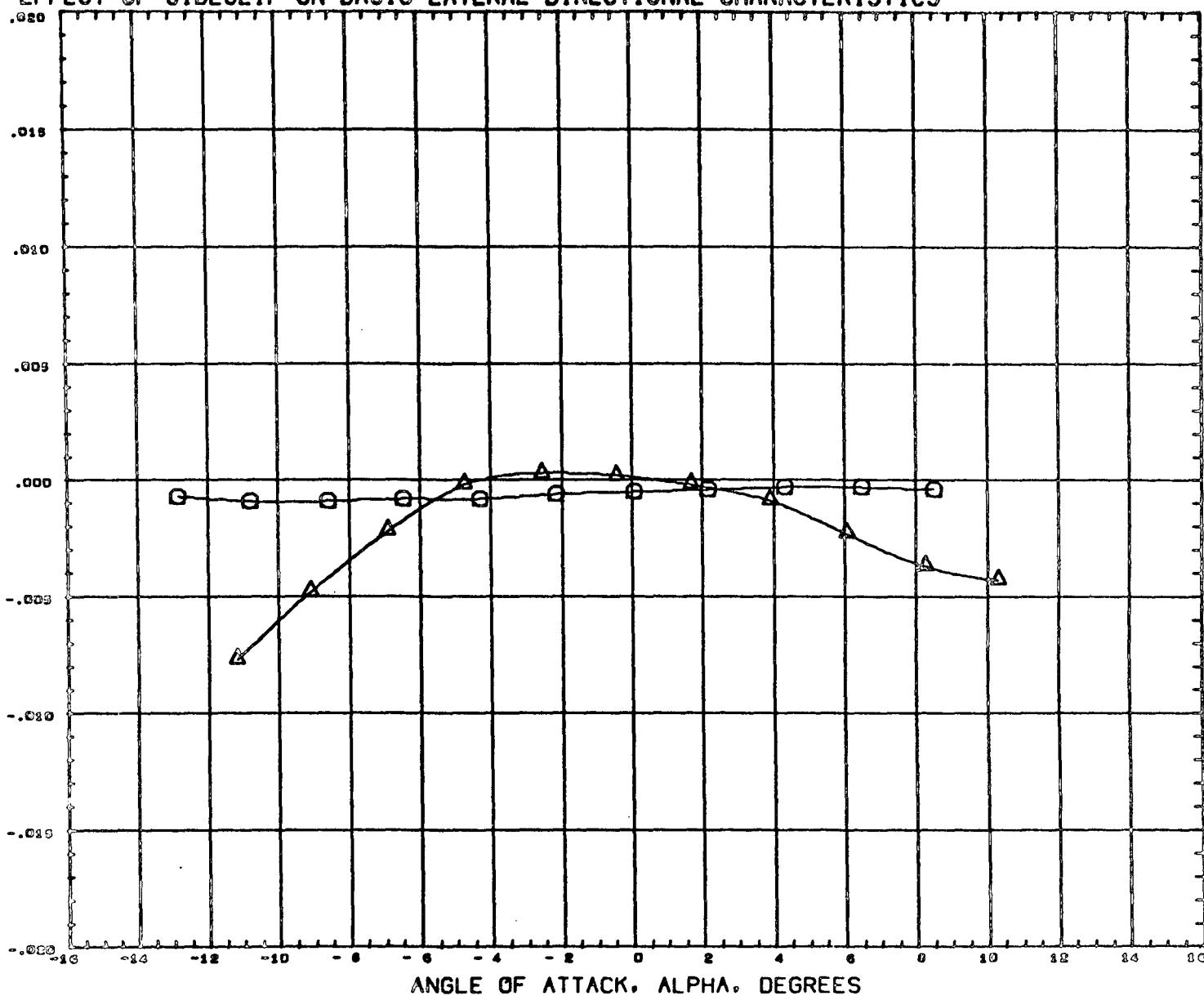
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ZMRP	0.0990	INCHES
SCALE	0.0044	SCALE

MACH 1.198

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION

(AS107A) MSFC500 NR 110C ORBITER + TANK B12W26E16V36  
(AS100A) MSFC900 NR 110C ORBITER + TANK B12W26E16V36

BETA

0.000  
-6.000

REFERENCE INFORMATION

SREF	0.4420	89 IN
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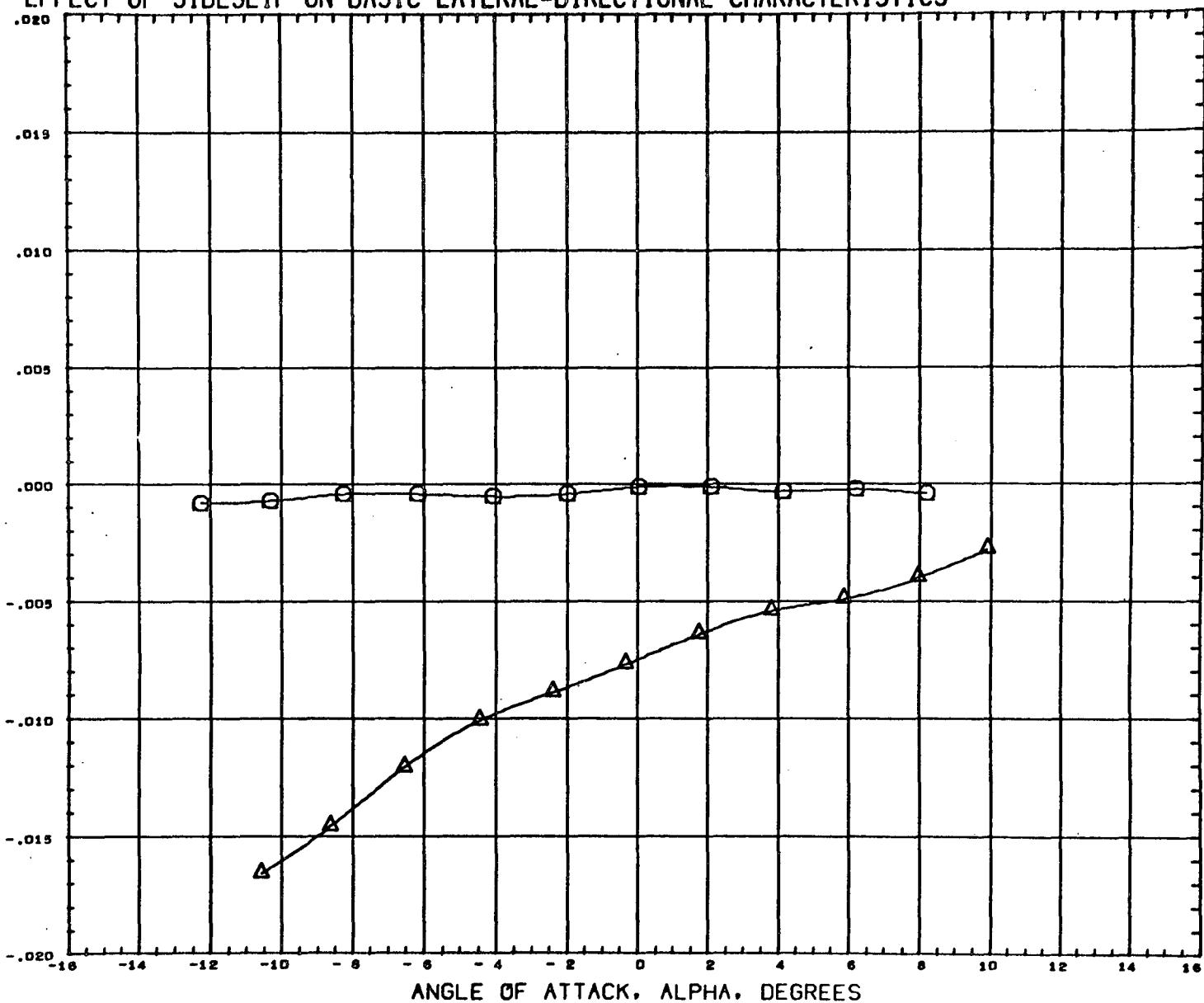
MACH

1.865

PAGE 190

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (AS107A) MSFC509 NR 11OC ORBITER + TANK B12W26E16V36  
 (AS106A) MSFC509 NR 11OC ORBITER + TANK B12W26E16V36

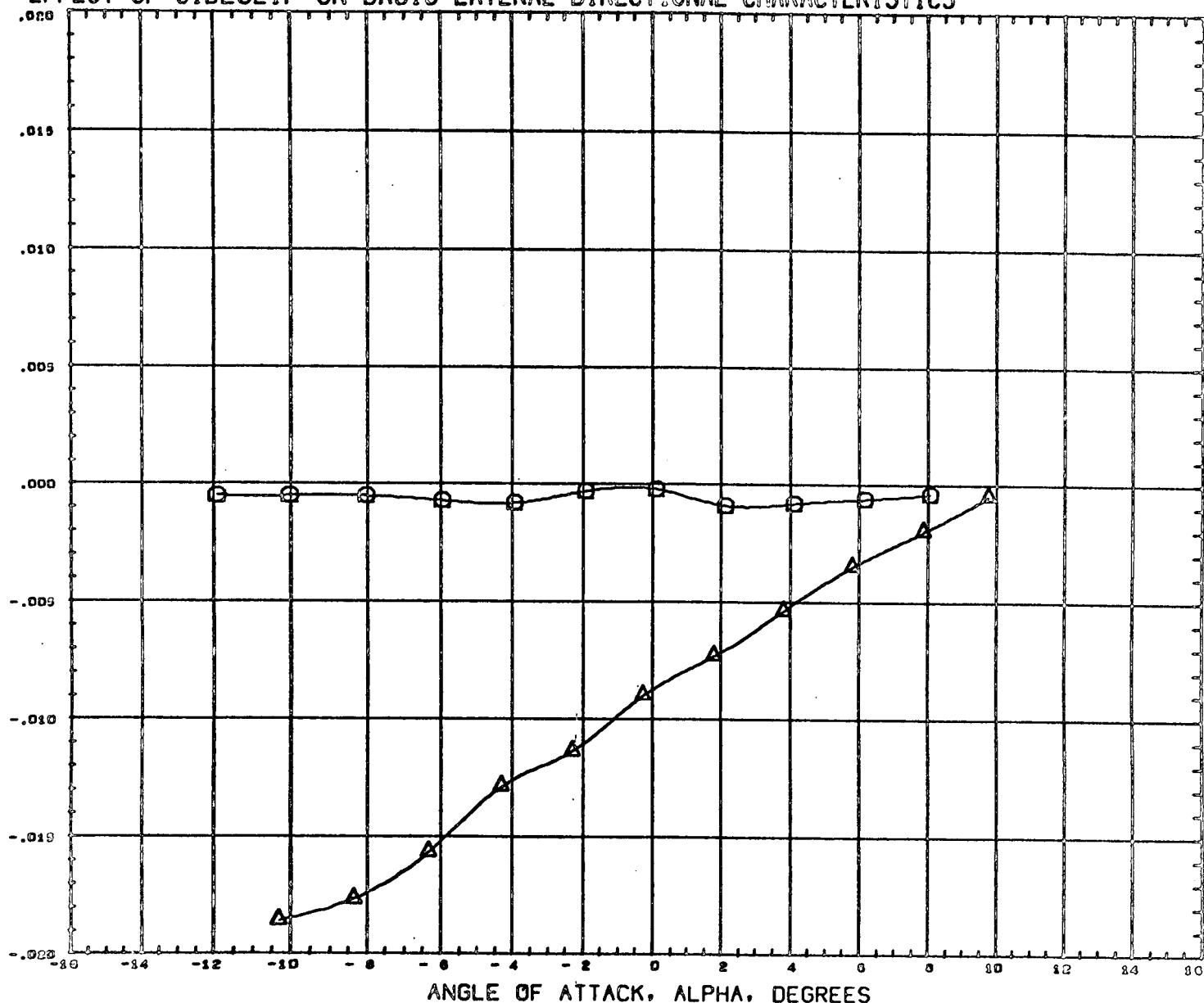
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REFERENCE INFORMATION  
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 ZMRP - 0.0990 INCHES  
 SCALE 0.0044 SCALE

MACH 2.990

# EFFECT OF SIDESLIP ON BASIC LATERAL-DIRECTIONAL CHARACTERISTICS

ROLLING MOMENT COEFFICIENT, CSL (STABILITY AXIS)



DATA SET SYMBOL CONFIGURATION DESCRIPTION  
 (A9107A) Q M0FC506 NR 110C ORBITER + TANK B12W26E16V36  
 (A9100A) Q M0FC500 NR 110C ORBITER + TANK B12W26E16V36

BETA  
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 SCALE 0.0044 SCALE

MACH 4.959